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JULY 1948

REPAIR OF TENDON INJURIES IN THE HAND

INTRODUCTION

THE HAND IS constantly exposed to risk of injury from early childhood to the end of life. There is no lack of material for the surgeon whose special interest lies in the hand, and there can be few fields of surgical endeavour to-day where a new consciousness of our responsibility is more needed, both in treatment and in the organization of our casualty departments.

All injured hands should be assessed by an experienced surgeon before treatment is commenced. It is not always possible to restore function to a severely damaged finger, and when tendon division is combined with extensive skin loss or severe bone or joint damage, amputation may save unnecessary invalidism and stiffening of the remaining fingers. Injuries involving the thumb or more than one finger demand a more conservative judgment, as even a portion of finger may be of use to the mutilated hand.

The problems of late repair must also be approached in a critical spirit. It is unwise to attempt tendon reconstruction in the presence of severe scarring, trophic changes from digital nerve damage, or under the handicap of a stiff joint. These complications must receive attention before tendon surgery is undertaken, otherwise the results will be consistently disappointing.

Surgery of the hand requires the combined basic knowledge and experience of the Plastic surgeon, the Neuro-surgeon and the Orthopædic surgeon. It is obviously undesirable for three specialists to work on one case, and the hand should be considered as a regional problem. In the United States, a speciality of hand surgery has been developed under the leadership of Sterling Bunnell who delivered the first Presidential address in January, 1947, to the American Society for Surgery of the Hand.

This paper is concerned, not with the reconstruction of the hand ravaged by trauma or sepsis, but with the treatment of isolated tendon injuries. One of the main foundations of reconstruction of the hand lies in the ability to deal with the straightforward tendon division, and it is my intention to confine my remarks to this subject.

The Physiology of Tendon Repair

Synovial sheaths enclose those tendons which pass over joints and flex them through an angle. Tendons which slide in constant straight lines or which straighten joints from the flexed position are surrounded by Paratenon, a loose filmy connective tissue containing elastic fibres.

Tendons held in apposition by external splintage or by internal suture, heal in an orderly and progressive fashion. A fibroblastic reaction takes place in the tendon sheath or paratenon and glues the tendon ends together during the first week. Tendon cells grow out from the cut ends into this mass and the gap becomes bridged during the second week. This phase is characterized by maximum vascularity of the tendon and surrounding tissues. During the third week resolution sets in and the tendon union becomes firmer until the junction takes on the appearance of normal tendon.

It is clear that the process of repair is associated with considerable reaction, increased by the healing of the operative wound. This physiological reaction subsides in due course, but if immobilization is continued for too long a time, firm adhesions develop which bind the tendon to its immediate surroundings. The result may be that, although tendon continuity is restored, the tendon is incapable of fulfilling its function. This tendency to form adhesions is most marked in the digital theca, and the repair of tendons or graft replacement in the fingers or thumb must be followed by very careful after-treatment. Mason and Allen have shown by experimental work that active movement, commenced soon after suture, results in an increased tissue reaction; whereas the tendon immobilized during the period of healing shows less irritative reaction and attachment to its surroundings. This work is not, I believe, entirely confirmed by the observation of post-operative progress, and I have found that some of my better results after flexor tendon grafts have followed an early commencement of active movements. A few cases which have been immobilized for 21 days have shown very delayed or incomplete recovery.

No reliance can be placed on the tendon union until well on in the fourth week and if early movements are to be encouraged, the technique of suture and the materials used must be faultless, as the strain falls directly upon the suture material.

Principles of Treatment

Immediate or Delayed Repair. It is not only useless but dangerous to undertake immediate tendon repair unless certain fundamental conditions are satisfied.

(1) The wound must have been caused by a reasonably clean instrument —a wound contaminated by soil or milk is not suitable.

Crush injuries are not suitable as there may be necrosis of tissue beyond the limits detectable by the naked eye.

(2) Cases complicated by skin loss and fracture or joint injuries are

unsuitable for immediate repair. Nerve injuries are not necessarily a contra-indication, as nerve suture may be performed at the time of operation.

(3) Treatment must be instituted within a reasonable time of wounding. Six hours is the generally accepted time, but one must not be bound by a firm rule, and clinical judgment will sometimes extend this arbitrary period.

(4) Operative conditions must be adequate and the correct instruments and suture materials available.

(5) Tendon repair is precise work and if a competent surgeon is not available, the emergency operation should be limited to a careful wound toilet and skin suture. Subsequent elective treatment may be carried out once wound healing is complete.

The Problem of the Flexor Tendon. It is not difficult to suture tendons and prepare the ground for sound union; the real problem is to obtain a freely sliding tendon capable of restoring good function.

Extensor tendon divisions yield uniformly satisfactory results by immediate or delayed suture, but flexor tendons, particularly when severed in the narrow digital theca or deep to the transverse carpal ligament, are likely to adhere to their surroundings, if sutured in these areas. The junctions should be placed where adhesions will not form so readily and where the tissues are more loosely arranged as in the palm or forearm. Immediate or delayed repair of flexor profundus in the distal half of the finger will give satisfactory results, provided severe retraction has not occured. When both superficial and deep tendons are severed between the proximal flexion line of the finger and the distal palmar crease, it is better to replace both tendons by a single free graft reaching from the terminal phalanx to a position well proximal in the hand. The graft, with its own paratenon will constitute a new sliding assembly which is less likely to become adherent. The original sublimis or profundus may be employed as the motor power, but if the muscle has lost its contractible power owing to delay and severe retraction, one must be prepared to use sublimis of an adjacent finger to take its place. It is better to have two digits with profundus action only, than to have one completely normal finger and the other functionless. The lack of sublimis is not serious and although the final clench may be absent, the power for ordinary use is not affected.

General Technique

Restoration of function depends upon full joint mobility and a freely gliding tendon; operative technique must, therefore, be designed to avoid any undue fibrosis or cicatrical contracture. The tissues must be handled with the greatest care and Bunnell uses the descriptive phrase " Atraumatic Surgery." The most delicate instruments are employed and all crushing of tissues and unnecessary interference with sliding surfaces avoided. The minimum of foreign material is left in the wound. A bloodless field

is ensured by the use of a pneumatic tourniquet, released for 5-minute intervals at the end of each 1½-hour period. Before the wound is closed, the tourniquet is released and a hot saline swab applied with the limb elevated for a few minutes. The tourniquet pressure is renewed, the wound closed and a firm compression bandage applied before blood is permitted to re-enter the limb. It is possible in the majority of cases to dispense with the use of any ligature material. A short post-operative course of Penicillin is advisable, as even minor degrees of sepsis will delay healing and lead to fibrosis.

The suture material should be fine but strong and of a nature which causes the least possible irritation to the tissues. Stainless steel wire is the most suitable material at present available. It causes little or no reaction and, provided kinking is avoided, it is sufficiently strong (gauge 40) to permit guarded active movements before physiological union has taken place. The wire should be obtained in 18-inch lengths with a small cutting needle attached to each end. The wire may remain buried in the tendon indefinitely without giving rise to tissue reaction.

The type of suture to be used depends upon the conditions present in each case, and there are three reliable methods in common use :—

(1) Bunnell end-to-end stitch for joining two tendons of approximately equal diameter.

(2) Double-right-angle stitch for use when multiple tendon divisions require repair and a simpler and more rapidly applied stitch is desirable.

(3) Interlacing stitch for joining two tendons of unequal diameter.

The removable stitch of Bunnell is an ingenious method devised to fulfil the principle that the least traumatic suture material is the one that is not present. It is widely used in the repair of tendons, but I am not personally convinced that it has sufficient advantage over the retained stitch to use as a general procedure.

Many materials have been used to insulate the tendon junction in order to limit adhesion formation. Free fat, fascial, and paratenon grafts and aminoplastin have all been given a trial but none, I believe, serves a useful purpose and it is wise to make use, if possible, of tissues which are readily available at the site of suture. The paratenon surrounding a free graft may be drawn along to cover the junction, and when the suture line is in the palm, the join may be buried in lumbricalis muscle.

The incision should be carefully planned to follow the natural skin lines where possible and never should a natural flexion crease be crossed, as contractures or keloid formation will follow.

The post-operative routine depends upon the site of the injury, and the type of repair employed and will be discussed in detail later. Rapid progress may be expected after extensor tendon suture but flexor tendon repairs and all free graft procedures are followed by a gradual restoration of the function, and it is often 6-12 months before the final result can be assessed.

Extensor Tendon Repair

Distal Inter-phalangeal Joint. Mallet finger deformity may be caused by rupture of the extensor tendon insertion to the distal phalanx, avulsion fracture of the base of the phalanx, or by open division of the tendon.

Rupture or division of the tendon may be successfully treated by splintage if instituted within the first 3-4 weeks after injury. Splintage must be accurate and maintained for 6-7 weeks. Plaster or moulded aluminium may be' used and should include the full length of the digit, maintaining the proximal inter-phalangeal joint in flexion and the distal joint extended.

Avulsion fractures are sometimes associated with forward subluxation of the distal phalanx and these cases are well treated by open reduction and fixation of the fragments by stainless steel wire, using the removal suture technique.

Late cases of tendon rupture or division should be repaired by operation. An inverted "L-" or "U-" shaped incision is made and the tendon carefully freed by small scissors from the overlying tissues and from its adhesion to the middle phalanx. It is almost invariably found that union has occurred, but with lengthening. A small length (1-2 mm.) of tendon is excised and a careful end-to-end suture performed using gauge 40 wire. Splintage is maintained for 5-6 weeks, followed by movements combined with protective splintage designed to prevent undue flexion strain.

Satisfactory results can usually be obtained by this method, and as the only other possible procedures are an arthrodesis of the inter-phalangeal joint or a partial amputation, a determined effort to effect repair is justifiable.

Proximal Inter-phalangeal Joint. Rupture or division of the central tendon slip attached to the base of the middle phalanx allows the two lateral bands to slip in a volar direction. The proximal inter-phalangeal joint is thus flexed and the distal joint extended, giving rise to the typical deformity.

Early cases of moderate severity can be restored to full function by splintage in extension for 5-6 weeks. Late cases should be treated by operation. A curved incision around the side of the joint is used and one of two repair techniques may be employed. In most cases the central slip can be re-attached by wire to the middle phalanx. In neglected cases this may not be possible and an alternative method is to release the lateral bands and suture them together over the dorsal aspect of the joint.

Metacarpo-phalangeal Joint and Dorsum of Hand. Tendon division at these levels is not followed by appreciable retraction. A case seen within a week or two of injury may often be treated successfully by splintage in extension for 5-6 weeks. Delayed cases should' receive surgical repair using an end-to-end suture and subsequent splintage holding the metacarpo-phalangeal joint extended and the inter-phalangeal joints moderately flexed.

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Wrist. Operative repair is always required, and the decision to perform an immediate tendon repair in a recent wound, or to perform wound toilet only, followed by delayed tendon repair, must be made for each individual case.

Cases with severe destruction and loss of tendon by trauma or infection may be reconstituted by joining divided tendons to intact tendons or by free graft replacement.

Attrition Rupture of Extensor Pollicis Longus. Rupture of extensor pollicis longus at the level of Lister's tubercle is an occasional complication of Colles fracture or simple posterior cortical crush of the radius. The condition may develop as early as 3 weeks after injury while the limb is still in plaster, or not until 3-4 months later. It is easily recognised and the operation of tendon transference gives most satisfactory results.

Direct suture is not advisable on account of the fraying of the tendon at the site of rupture and also because further fraying and rupture may occur. Extensor carpi radialis longus or brevis have been used as transfers, but the amplitude of movement is insufficient. Extensor indicis proprius is the most suitable tendon to use—it is of the correct size and range of movement, and the index finger rarely suffers by its loss.

Extensor indicis proprius is divided at its attachment through a $\frac{1}{2}$-inch transverse incision just proximal to the metacarpo-phalangeal joint, where the tendon lies to the ulnar side of extensor digitorum communis. The extensor pollicis longus is exposed by a 1-inch transverse incision at the level of the wrist joint. Extensor indicis is located and withdrawn into the wound. It is joined to extensor pollicis by an interlacing suture, obtaining reasonable but not exaggerated tension. Plaster fixation is employed for 4 weeks and full restoration of function is usually seen in 8-10 weeks.

Flexor Tendon Repair

Profundus Tendon. The profundus tendon may be torn from its insertion by a forcible extension strain of the terminal phalanx or the tendon may be divided in an open wound. The general function of the hand is not grossly impaired and in certain cases it is justifiable to accept the disability, particularly if the case is not seen immediately.

If an open division is seen immediately after the injury the choice of treatment must be guided by the main principles already described. If any doubt exists, it is wiser to perform skin toilet and suture and deal with the tendon injury when the skin has healed.

Immediate suture with stainless steel wire can yield almost perfect results. Delayed suture is also satisfactory provided the lapse of time has not been sufficiently long to allow severe retraction and secondary shortening of the muscle to occur. Four weeks is a reasonably safe limit. After this period it is difficult to secure end-to-end apposition, and replacement by a free graft is the more satisfactory procedure.

The decision to attempt restoration of profundus by grafting is one requiring careful judgment. It is clearly unwise to perform a standard flexor graft and in doing so remove a good functioning sublimis; an unsuccessful result carries with it the certainty of a finger rendered useless by interference and the risk should not be accepted. If a graft is employed sublimis is better left undisturbed and a thin graft (e.g. toe extensor) used to replace profundus. Success can be achieved in most cases, but if the result does not come up to expectation, no harm has been done and the finger still has sublimis action.

Profundus and Sublimis Tendons. This injury presents the most difficult single tendon problem in the hand, and it is largely due to the work of Bunnell, Mayer, Koch and Mason, that the treatment of this injury has been placed on a sound basis.

The beautiful sliding action of the tendons in the digital theca makes one feel doubtful that restoration of function can ever be achieved by surgical treatment, but it has now been shown repeatedly that excellent results can be obtained provided accurate and correct methods are employed.

Immediate tendon repair must only be undertaken when ideal conditions are satisfied. When immediate suture is deemed wise, it is useless to attempt suture of both tendons. Local adhesions binding the tendons together are inevitable with the loss of function. Profundus alone is sutured and sublimis completely removed. There are two methods of suture available; suture at a distance as described by Bunnell with subsequent removal of the wire, and local suture with retention of the wire. Bunnell uses 34-35 gauge wire and withdraws it after approximately three weeks, when the tendon is physiologically united. For a full description of Bunnell's method the original work should be consulted.

In those cases in which immediate operation cannot be safely undertaken on account of the nature of the wound or lack of facilities, wound toilet and skin suture alone should be employed and a free tendon graft operation performed when the wound is safely healed, all reaction settled and full passive mobility restored. Tendon replacement by a graft ensures that the junctions are in safe areas where adhesions are not likely to occur. Tendon unions between the distal crease of the palm and the proximal crease of a finger will adhere to the digital theca. When tendons are divided in this dangerous area it is wiser always to perform a secondary graft operation even though the wound conditions permit primary suture.

THE TENDON GRAFT OPERATION—*Site of Graft.* There are several possible grafts available. Palmaris longus is perhaps the one most often employed, and is present in approximately 90 per cent. of subjects. It is suitable size and length and can readily be removed. It should be taken with its surrounding paratenon by open dissection and not by the use of a tendon stripper. Sublimis of the same finger may be

used, but this tendon is sometimes found to be a little too thick to pass easily through the thecal tunnel over the middle phalanx—nor is the tendon surrounded by paratenon. The long extensor tendons of the 2nd, 3rd, 4th and 5th toes are suitable. These tendons are somewhat thin, but appear to stand subsequent strain well and by reason of their small size are readily revascularised. They also run easily through the thecal pulleys. The tendons are removed by open dissection with their paratenon, through a curved incision on the antero-lateral aspect of foot and ankle.

Other tendons that may be used are plantaris, if present, extensor indicis proprius and flexor carpi ulnaris, but the latter tendon is thick and not really suitable.

Technique. The whole length of the digit is exposed by a true mid-lateral incision which carries the line of dissection posterior to the digital vessels and nerve. The sublimis and profundus tendons are completely removed, except for a small tag of profundus attachment. A pulley is preserved over the proximal and middle phalanges. The palm is exposed by an incision in the proximal palmar or thenar crease and the proximal end of the tendon drawn into the palm. It is usually found that the proximal end of the tendon is adherent in the blind area between the palm and finger incisions. Considerable effort and patience is necessary to secure its complete removal, which is essential to clear the thecal channel. A tendon stripper has been recommended, but I believe that careful dissection from each end is less traumatic. The channel between finger and palm is then stretched by the use of increasing sizes of Hagar's dilators and the graft finally threaded through from palm to finger and then through the pulleys previously preserved in the finger.

The proximal suture is performed as far proximal in the palm as practical. The method of suture depends upon the size of the graft. If the graft and profundus tendon are of approximately equal diameter an end-to-end suture is used. On occasions when the graft is much smaller than profundus, an interlacing suture is used. The distal suture may be made either to the remaining tag of profundus tendon or to the terminal phalanx. It is usually found that the former is the more simple and satisfactory method.

If it is found impossible to use some of the existing fibrous sheath as a pulley, a new pulley may be constructed over the middle phalanx by encircling the bone by a thin strip of tendon.

The final tension should cause the finger to lie in the correct relationship to the other fingers while under anæsthesia, i.e., the index finger flexed least and the little finger flexed most. Suture lines should be secure and tested before final skin suture is performed.

After-treatment. It is usually recommended that a protective splint holding the wrist in flexion should be employed for approximately three weeks and Bunnell advises that movement should not be permitted for the first 15-21 days.

I have employed several forms of after-treatment varying from immediate gentle active movements to complete immobilization for 2-3 weeks. My conclusions are in favour of early movements and my present routine is to use a wool and crêpe bandage splintage, so adjusted as to avoid external strain on the finger but permitting flexion to occur.

Active movements of a gentle nature are permitted from the second day. The hard blood-stained dressings are changed 5-6 days after operation and from then onwards gradually increasing movements permitted. It is exceptional for the suture lines to give way under ordinary active movements, and in only one case has this occurred, but every precaution must be taken to prevent undue passive strains. At the end of three weeks, more vigorous exercises may be gradually developed and occupational- and physio-therapy used to encourage movements. The final result cannot be judged for 6-12 months from operation but in most cases the patient can return to useful occupation at four months.

Thumb. Flexor pollicis longus can be sutured directly with good prospect of success. Immediate or delayed repair should be undertaken according to the conditions of wounding already discussed.

Suture is sometimes impracticable owing either to passage of time and severe retraction or to marked cicatrical formation. In these cases a free graft, or one of the two following procedures, may be used. Flexor pollicis longus may be lengthened in the forearm by a slide at its musculo-tendinous junction and $1\frac{1}{2}$-2 inches extra length obtained which may permit suture at the terminal phalanx. This is a useful technique when division has occurred at the level of the proximal phalanx and where retraction prevents direct suture. Cases in which both muscle and tendon have been destroyed require a complete muscle-tendon replacement and this can be obtained by transferring a flexor sublimis unit from a suitable finger to the thumb.

Palm. Tendon division in the palm does not present the difficulties encountered within the digital theca and immediate or delayed direct suture, according to circumstances, can be employed with full expectation of success.

Late cases in which retraction and lack of muscle elasticity does not permit end-to-end suture, may be restored by bridging the gap in profundus by a free graft taken from sublimis, or by transferring flexor sublimis of a neighbouring finger to the distal end of the divided profundus tendon. The donor finger does not suffer appreciably by loss of its sublimis. It is important not to remove sublimis near its insertion, as a hyperextension deformity of the proximal inter-phalangeal joint may occur, causing an objectionable locking of the joint and difficulty in initiating flexion.

The palm can be readily exposed by an incision in the appropriate palmer or thenar crease. The incision may be extended in a proximal direction from the ulnar side of a palmar crease if necessary.

Multiple Tendon and Nerve Division at the Wrist Level. This presents a formidable surgical problem and opinion differs as to the correct precedence of nerve and tendon suture. Nerve suture is technically easier and more satisfactory if it is delayed for several weeks after division. The nutrition of the hand, however, depends to a large extent on nerve function, and will be defective until the nerve is restored. Tendon repair should be performed as soon as practical, for delay allows adhesions to form; the multiple tendon ends become glued together and muscle retraction renders subsequent end-to-end suture more difficult.

The ideal procedure is to perform a complete nerve and tendon suture immediately following the injury if wound conditions permit. If the wound conditions are unfavourable or the surgeon inexperienced, it is wiser to perform a wound toilet and skin suture only, followed by formal repair when safe wound healing has occurred.

When repair cannot be undertaken for some weeks or months it is usually impossible to secure end-to-end tendon apposition and it is necessary to fill the gaps in profundus tendon with sublimis grafts.

Tenolysis

The release of a tendon bound down by scar tissue resulting from trauma or infection is often followed by remarkable improvement in function. A careful assessment must be made to determine whether there are any complicating factors present before tenolysis is performed. Passive joint mobility must be satisfactory and there should be no secondary skin contracture. In the case of post-infective adhesions the risks of awakening a dormant infection must be carefully considered.

The operation is tedious but not difficult. It is a common experience to find that the adhesions are more widespread than was expected and skin incisions must be planned so that they can be enlarged if necessary. The tendon is completely cleared of all adhesions, including the illusive bands which run for some distance alongside a tendon before the attachments to surrounding tissue are discovered.

A proximal exposure of the tendon or muscle should be made in order to determine that a free and unrestricted normal action is present before the operation is completed.

No attempt is made to cover the tendon with transplanted glide material, and reliance is placed entirely on the after-treatment for prevention of further adhesions.

Immediate active movements are essential. The hard blood-stained dressing is changed a day or two after operation and active movements started, assisted by faradism.

The results are usually very satisfactory and, at times, dramatic in the degree and speed of recovery.

Results

This study is based upon a total number of 130 examples of various types of tendon repair and tenolysis operations. The following analysis is an attempt to evaluate the results :—

Case 1   Index finger.   Divided expansion over proximal inter-phalangeal joint. Immediate suture.

Case 2.   Little finger.   Divided expansion over proximal inter-phalangeal joint. Centralisation of lateral slips.

Case 3.   Thumb.   Restoration of 2″ gap in extensor pollicus longus by free graft.

Case 4   Thumb.   Attrition rupture of extensor pollicus longus.   Transfer of extensor indicis proprius to extensor pollicus longus.

Case 5   Middle finger   Divided flexor profundus   Immediate suture
(Operation by S/Ldr J J Williams)

Case 6.   Little finger   Divided flexor profundus and sublimis in digital theca.
Palmaris graft.
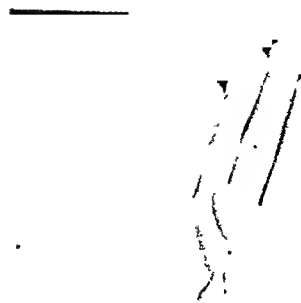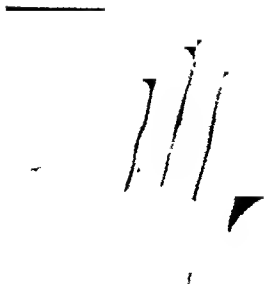
Case 7. Thumb. Divided flexor pollicus longus in digital theca. Delayed suture.
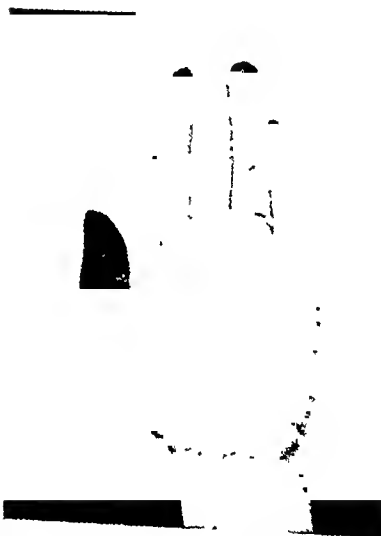
Case 8. Palm. Divided flexor profundus and sublimis to ring and little fingers. Delayed suture of profundus.

Case 9. Palm. Divided flexor profundus and sublimis to little finger. Restoration of 1" gap in profundus by free sublimis graft.
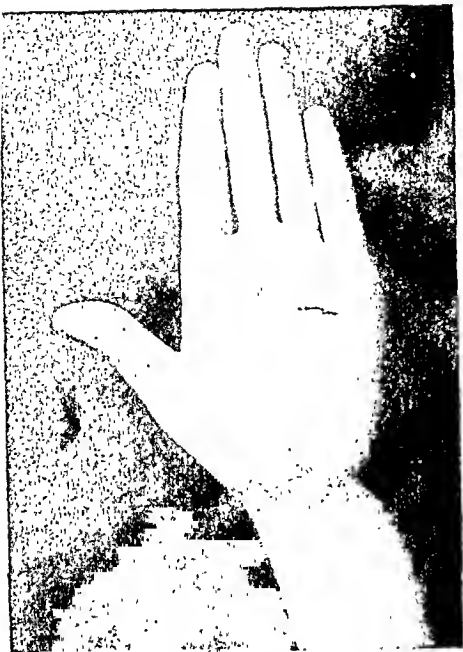
Case 10. Palm. Divided flexor profundus and sublimis to ring finger. Transfer of middle finger sublimis to ring finger profundus.

Case 11. Index finger. Divided flexor profundus and sublimis at base of fingers. Immediate suture and later tenolysis. (a) Maximum flexion before tenolysis. (b) Maximum flexion after tenolysis.

Extensor Tendons

(1) Division over the distal inter-phalangeal joint (mallet deformity). Ten cases were treated by the method described.

90-100 per cent. recovery	5 cases.
70-80 per cent. recovery	3 cases.
No improvement	1 case.
No follow up	1 case.

(2) Divisions over the proximal inter-phalangeal joint (button-hole deformity), were treated by various methods. (9 cases.)

Immediate suture—3 cases, all showing complete recovery.

Delayed suture—

| Suture of central slip | 5 cases, all showing complete recovery. |
| Centralization of lateral slips | 1 case, showing 80 per cent. recovery. |

(3) Division over the metacarpo-phalangeal joint. (8 cases.)

Immediate suture—3 cases, all showing complete recovery.

Delayed suture. (5 cases.)

| Complete recovery | 4 cases. |
| 90 per cent. recovery | 1 case. |

(4) Division at the level of the hand and wrist. (24 cases.)

Immediate suture—8 cases, all showing complete recovery.

Delayed suture. (5 cases.)

| Complete recovery | 3 cases. |
| 80 per cent. recovery | 2 cases. |

Tendon transference. (8 cases.)

| Complete recovery | 4 cases. |
| 90 per cent. recovery | 4 cases. |

Free grafts. (3 cases.)

| Complete recovery | 1 case. |
| 60 per cent. recovery | 2 cases. |

(5) Attrition rupture of Extensor pollicis longus. (9 cases.)

Transference of Extensor indicis proprius. (8 cases.)

| Complete recovery | 6 cases. |
| 80 per cent. recovery | 2 cases. |

Transference of Extensor carpi radialis longus. (1 case.)

80 per cent. recovery.

Flexor Tendons

(1) Profundus division in digital theca. (8 cases.)

Immediate suture—1 case, showing complete recovery.

Delayed suture—2 cases, showing 80 per cent. recovery.

Graft replacement, leaving sublimis intact. (5 cases.)

| Complete recovery | 1 case. |
| 50-80 per cent. recovery | 4 cases. |

(2) Profundus and Sublimis in digital theca.
Graft replacement. (20 cases.)

90-100 per cent. recovery	7 cases.
75 per cent. recovery	6 cases.
50 per cent. recovery	2 cases.
No impróvement	2 cases.
Too recent to assess	3 cases.

(3) Flexor pollicis longus in digital theca. (9 cases.)
Immediate suture—1 case with 75 per cent. recovery.
Delayed suture—1 case with 75 per cent. recovery. -
Elongation and suture. (4 cases.)

Complete recovery	2 cases.
50 per cent. recovery	2 cases.

Graft replacement—3 cases with 50-70 per cent. recovery.

(4) Profundus and Sublimis in palm. (9 cases.)
Delayed suture—1 case with complete recovery.
Transference of adjacent flexor sublimis. (7 cases.)

Complete recovery	1 case.
80 per cent. recovery	3 cases.
60-70 per cent. recovery	3 cases.

Free graft to bridge gap—1 case with complete recovery.

(5) Multiple tendon and Nerve division at wrist. (4 cases.)
Immediate suture

90 per cent. recovery	1 case.
50 per cent. recovery	1 case.

Free grafts

50 per cent. recovery	1 case.

Transfer of Flexor sublimis to Flexor pollicis longus

100 per cent. recovery	1 case.

Tenolysis

Twenty cases of various types are included in the series. The majority show a recovery of high degree and a small minority show improvement of a moderate degree.

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THE TREATMENT OF CANCER OF THE BREAST IN STAGES I AND II

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CLINICAL STAGING

IT IS NECESSARY to agree upon some form of clinical staging as a practical guide to determining the initial *treatment*. This is apart from the histological classification based on the freedom or invasion of the axillary nodes, which is required for the purpose of assessing and recording *results*, and survival rates.

Clinically, cases would appear to fall into one of the following broad categories :—

Stage   I.—TUMOUR only.

Stage II.—TUMOUR + AXILLARY NODES (mobile).

Stage III.—Disease advanced with *local* metastases.

Stage IV.—Disease advanced with *distant* metastases.

Difficulties in staging.—While the Steinthal (modified) method of staging has the merit of extreme simplicity it fails in many instances to give the precise guidance as to treatment and prognosis which should be the main purpose and achievement of a satisfactory method of staging. For example, suppose impalpable axillary nodes to be associated with a rapidly growing carcinoma in a young woman or an atrophic scirrhous in an aged person or an ulcerating growth—there is no alternative but to place all these widely different clinical varieties in the same group (Stage I). So far no entirely satisfactory method of staging has been devised but a classification in which consideration is given to those factors which are thought to have a bearing on prognosis, might be of great value provided it was not too complicated. In our present system no account is taken of such factors as age, site, rate of growth, relation to menopause, or extent of involvement of skin. In an attempt to take into consideration certain of these factors, Lee and Stuberford (1928) have suggested a formula which they call the Clinical Index of malignancy in which the chosen factors are given numerical values. This is not the place to examine this proposal any further, but complex as it sounds, it represents a genuine attempt to formulate a guide to treatment and

prognosis. It has been adapted by Richards of Toronto for presenting results in his recent paper (1948).

Natural history of the disease.—In considering the value of any method of treatment, it is fundamental that the treatment should be an improvement upon the natural course of the untreated disease. The average expectation of life in untreated cancer of the breast is three years and three months, Greenwood (1926), Nathanson and Welch (1936), so that any claim for any method of treatment must yield a longer survival period than this. Reports then, on 3-year survival rates are of little interest or value and as such should be given up. It is open to question whether 5-year survival rates which only exceed the natural history of the disease by 21 months do not give a false sense of values and might not be more instructively replaced by mortality rates for the same period. For these reasons it will probably be wisest in the future to insist on a presentation of at least 7-year and possibly 10-year survivals before passing a verdict on any of the methods of treatment at present in use.

Radium

In this lecture I shall only deal with the Radiosurgical aspects. of treatment. These two weapons are complementary to one another and form the spearhead of our attack upon carcinoma of the breast.

The first of the irradiation methods to be used effectively was radium. Whilst recognising the important contribution to the treatment of breast cancer made by the use of interstitial radium needles, it is now generally agreed that, except in isolated instances, the high voltage X-ray therapy plant can more conveniently achieve the same or better effects with greater accuracy and less disturbance to the patient.

Keynes, whose name is associated with this pioneer work, was the first to break away from the tradition of radical amputation of the breast, and to point the way in which future advances were likely to develop, that is to say, in a combination of simple mastectomy and irradiation of the undissected axilla. He has been able to show a 5-year survival rate by his method, which compares on even terms with the best results obtained by radical surgery (Keynes, 1937). Unfortunately, owing to the impossibility of maintaining a follow up during the war years (1939-45), no 10-year survival figures are available.

Apart from the risk of radium burns and a particularly painful and intractable form of neuritis which may follow the implantation of radium in the axilla, the method has certain other disadvantages:

First, the configuration of the breast itself makes a homogeneous irradiation of the whole organ with interstitial needles almost an impossibility.

Second, there may be difficulty in assessing the nature of the residual tumour in the axilla, which sometimes remains after treatment, or reappears after an interval.

Third, recurrences if they occur, particularly in the axilla, are likely to be radio-resistant and to require surgical removal.

Fourth, there is the more serious fact that in a high proportion of patients such residual tumour contains, on section, active-looking malignant cells, which so long as they remain, must be regarded as a potential source of metastatic carcinoma. The existence of these cells has been confirmed in a series of patients treated by the radium method of Keynes (without excision of the tumour) and subsequently followed up by radical mastectomy. This made possible the histological examination of breast and axillary contents and was reported in a Hunterian lecture in this College by Ross in 1939.

It would seem that a fair assessment of the radium technique would be to say that it has been a milestone of the first importance in the treatment of carcinoma of the breast, but that the disadvantages mentioned, the regulations restricting its availability, a considerable degree of ignorance amongst general surgeons surrounding its use, and most of all, the rapid rise and development of X-ray therapy, are the reasons why the radium method is no longer practised extensively in this country today.

X-RAY TREATMENT

Radiotherapy is still in the process of evolution and the relative merits of the different irradiation techniques are undecided. We can only speculate as to what the future may hold. Is it true that X-ray treatment is of advantage?—and if so, should the course be administered before operation or after operation and what are the risks entailed?

Limitations.

Skin tolerance and sublethal dosage.—The first obstacle is the patient's covering of *skin*, which forms a vulnerable and sensitive barrier. The presence of the skin through which X-rays must pass and, therefore, may damage, makes it impossible in many cases to give a lethal dose of X-ray either to the tumour or the axillary glands. Tightly stretched skin flaps, grafted areas, and areas which have healed by granulation and scar tissue formation, require especially careful attention. The dosage is thus only too often dictated by the *tolerance of the patient's skin* rather than the optimum that is cancercidal to the tumour.

Second course of X-ray treatment is contra-indicated.—Once a patient has had X-ray treatment taken to a full tolerance dosage level, the course, as a rule, cannot be repeated a second time without risk. The initial treatment produces a widespread endarteritis: this in turn diminishes the blood supply which reduces the tolerance of the skin to further exposures of X-rays. If a second exposure is given there is risk of skin necrosis.

Recurrences are radio-resistant.—Recurrences tend to acquire varying degrees of radio-resistance, and for this reason a second course is rarely as effective as the first. The explanation for the increased radio-resistance is probably the reduction in the local blood supply and the walling off of malignant cells by fibrous tissue as a result of the original X-ray treatment. Isolated skin nodules can be picked out for treatment and will respond but a large recurrence, for example in the axilla, is likely to require surgical removal.

Morbidity.—Radiotherapy has its own morbidity and apart from *radiation pneumonitis*, which has been largely abolished as a result of the glancing-field technique, severe *skin reactions* sometimes occur. It is not always remembered that a full course of X-ray therapy is a major undertaking, and that a proportion of patients are much *exhausted* by treatment. The time taken for a course of therapy by the fractionated method varies, but is generally about four weeks. Under this scheme the patient attends five times a week and each treatment lasts about half-an-hour. The whole of a pre-operative course and the latter part of a post-operative course can be carried out as an out-patient, but there is no doubt that patients receiving post-operative treatment are much less upset if they can have the first half of their treatment in bed.

The value of X-ray therapy. The persistence with which surgeons the world over continue to employ X-rays in the treatment of cancer of the breast in spite of its dangers and limitations is a demonstration of their faith in the ultimate value of this measure. Is this faith justified ?

There are still some surgeons and many doctors who believe that X-rays only do harm, or at least do no good. They do not believe in them. They have some reason for this attitude. Results of cases treated in the ten years before the war showed no clear advantage to be gained from using X-rays, and in some series (post-operative) they actually appeared to be a disadvantage. They were, at the best, unconvincing. Truscott (1947), (Middlesex Hospital Series), Roden (1944), Haagensen and Stout (1942), Cantril and Buscke (1946).

Causes of failure of radiotherapy in the past.—The poor results were due to a number of factors which should be borne in mind when we try to assess the value of modern X-ray therapy. It is no argument to say that because X-rays were ineffective in, say, 1930, that they are valueless today. These factors were :—

(i) *Inadequate dosage*, resulting from a too timid and conservative approach, the tendency being to give multiple intermittent suberythemal doses over a prolonged period, instead of pushing treatment to the limit of biological reaction.

(ii) *Inefficient apparatus*, resulting in an insufficient depth dosage.

(iii) *Haphazard* technique, due to failure to employ a *physicist* in the planning of treatment.

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With the correction of these various faults, the value of radiotherapy is becoming apparent. This is clearly shown in the following results :—

5-Year Survival Rates

	Roden (1944)	Marshall and Hare (1947)	Richards (1948)	Adair (1943)
Radical Surgery only ..	46%	38·6%	30%	63% in selected cases.
Radical Surgery plus irradiation	52% (pre- & post-)	52·1% (post-)	51% (pre-) 43% (post-)	49% (pre-) 54% (post-)

Further evidence of the value of X-ray therapy is afforded by the reduced frequency of recurrences in those who have had X-ray treatment as compared with those who have not :—

> from 39 per cent. to 14 per cent. with post-operative irradiation (McWhirter, 1948) and
>
> from 14 per cent. to 5 per cent. with pre-operative irradiation (Richards, 1948).

(POST)-Operative X-Ray Treatment

X-ray therapy can be given pre-operatively, post-operatively, or both. I will speak first of post-operative therapy as it has been more in vogue up to the present time than the other methods.

The scope of post-operative X-ray treatment.—Post-operative irradiation is given with the intention of destroying any islets of active cancer cells which may still remain in the field of operation after the primary tumour and the glands have been removed. The anterior mediastinal glands, which are so often invaded, are outside the field of operation and do not, by present methods, receive any special attention (unless radium needles have been used), but it is usual for the supra-clavicular area to be included.

Ideally the course should be given as a *continuation* of the surgical treatment. It is not satisfactory to have an interval between the two forms of treatment, either from the point of view of the patient's morale or for the most effective irradiation. Radiotherapy can, and should, be started as soon as the wound is healed, and in satisfactory cases this is likely to be any time after the tenth day, administrative conditions permitting.

Indications and contra-indications.—Should radiotherapy be given to every patient who has had a mastectomy ? Theoretically, it should be, unless a pre-operative course has already been given, because of the definite added margin of safety it appears to offer. The younger patients should receive it almost as a routine. In individual cases, particularly amongst the older women, it may be judged wiser for some special reason to omit post-operative therapy altogether, but for the majority a full course should be advised.

Post-operative X-ray treatment to gland-free cases.—The question is sometimes asked—should gland-free patients be given post-operative therapy? Many surgeons exclude their gland-free cases from X-ray treatment on the grounds that the operation is sufficient in itself for these patients. In these circumstances they say. they prefer to keep post-operative irradiation in reserve for the treatment of recurrences, should they appear. While such an opinion is controversial, it is also a considerable assumption, because it implies that *all* the axillary glands removed have been sectioned. This is possible, and it is certainly desirable, but it does not always happen. In a busy department, it is the exception rather than the rule for the pathologist to have either the staff or the time to dissect, section and examine every gland in every mastectomy specimen, with the result that sooner or later a gland invaded case is going to be reported on as gland-free. If the presence or absence of nodal metastases is the criterion on which one decides whether to give post-operative irradiation or not, a number of patients who might have received the treatment with advantage are going to be denied it at the optimum time, unless the pathological services are exceptional. The only safe procedure is to arrange for all these patients to have post-operative X-ray treatment.

The significance of delay. If post-operative X-ray treatment cannot be started at the optimum time because of some delaying factor, is there a maximum time interval after which it is considered not worth while giving. a course ? If so, what is that interval—is it weeks, months or longer ? The answer is that we cannot be dogmatic. My practice is that after four months, if there are no metastases, the patient is given the benefit of the doubt and kept under close observation without giving radiation. This is because the patient is likely by then to have developed metastases (if she is going to) and not because the X-ray treatment is ineffective in relation to the tumour that might be present. .

(PRE)-Operative X-Ray Treatment

Pre-operative irradiation is given with the intention of sterilising or restraining the activity of the tumour and the glands. The precise indications for pre-operative irradiation with X-rays have not been finally settled. Until recently the method has been used almost exclusively in the treatment of the more advanced cases, but there is every indication that in the future it is likely to be used much more extensively also in early cases. A favourable report has recently been published by Richards (1948) and an unfavourable one by Adair (1943). What are the difficulties of pre-operative X-ray treatment and what are the advantages ?

Difficulties.

Diagnosis of malignancy. A positive diagnosis of cancer is required before pre-operative irradiation can be contemplated. Such a conclusive diagnosis on purely clinical examination can only be made with certainty in the comparatively advanced cases. This means that a biopsy will

have to be carried out on all the earlier cases and this is a procedure which surgeons are opposed to unless it can be followed very quickly by surgery. For this reason and others (see below) it would seem prudent for the time being, for those surgeons who do not work in close association with a radiotherapy centre to confine their use of pre-operative irradiation to selected cases in Stage II until trials have shown that this form of therapy is to be preferred at all stages of the disease.

Delay before operation.—When pre-operative irradiation by the fractionated method is employed there is necessarily a considerable delay—rarely less than ten weeks (four weeks therapy and six weeks for skin recovery)—before the patient is able to undergo her operation, and this wait is very irksome to some patients. It may also be harmful. Some authorities consider that valuable time is being lost. All we can say at present is that while it is clearly not an ideal arrangement we do not know how serious, if at all, the delay in postponing the operation may be.

Operation refused.—Some patients at the conclusion of the X-ray treatment may refuse the operation altogether, when they find that their lump has disappeared.

Operation difficulties.—One sees it stated that pre-operative irradiation makes subsequent operation technically more difficult because of increased bleeding. This has not been my experience with post-irradiation mastectomies. The tendency to ooze is a little greater and the tissues are a little more friable, but on the whole the operation is quite straightforward, and the increase in vascularity cannot be compared with that, for example, following thiouracil therapy in toxic goitre. In a post-irradiation mastectomy it is more important than ever that the edges of the wound should be closed without tension.

Sloughing of skin flaps. The irradiation-operation interval. If mastectomy is carried out before the skin reaction has developed, there is the risk that in point of time this may coincide with the healing of the skin flaps, in which case separation of the edges of the wound or sloughing may occur. The optimum irradiation-operation interval is not known, but must be long enough to allow the skin to regain its natural healing qualities, and not so long that regrowth of tumour cells is possible. The optimum time for operation would appear to be about six weeks after the termination of X-ray therapy.

Advantages.

Has pre-operative irradiation any special advantages? I think we can say that it has—at least on theoretical grounds.

First.—Pre-operative irradiation is more reliable than post-operative in the sense that there is no delay in starting the treatment (except administrative), whereas post-operative may be long delayed by some unforecastable complication of the operation. This point has an important

practical bearing in those cases in which delayed healing of the wound can be anticipated pre-operatively.

Second.—It is suggested that if radiation precedes operation, any cells which may be disseminated are either dead or have their vitality so reduced that they are not harmful.

Third.—It is probable that a heavier dose of X-rays can be given where there has been no previous trauma. This is because the blood supply to the skin and underlying muscles is still undisturbed with the result that the skin tolerance is high. We do not know how much the pre-operative dosage can safely be increased above the post-operative, if at all—it may be considerable, although this seems improbable.

Fourth.—It is possible that cancer cells, whose blood supply has not been damaged, may be more radio-sensitive before operation than after operation. This point has not yet been established, but should it be so, pre-operative X-rays might prove of considerable importance in reducing the frequency of recurrences in the skin. Hopeful signs pointing in this direction have been noted and reported by Roden (1944), Richards (1948), but in such short series the inferences drawn must be accepted with reserve.

Limitations.

Pre-operative X-ray treatment of FIXED axillary glands. There is a limit to the scope of pre-operative therapy. It is commonly held that in certain cases pre-operative X-ray treatment can convert the surgically incurable case into a surgically curable one. I think this is highly controversial. The commonest example we see is the patient with a fixed mass of axillary glands. I believe the only accurate assessment of operability is the clinical one, and that if the case is judged clinically incurable by surgery, no amount of X-ray treatment will convert it into a surgically curable case, however much the tumour mass may " appear to disappear " as a result of radiotherapy.

It is true that the effect of a full course of X-ray therapy can be quite remarkable, and in radio-sensitive cases, at the end of treatment, no lump whatsoever may be palpable where previously there was a fixed mass. It is very tempting in these circumstances to proceed to radical mastectomy, but my own conviction now is that this is wrong. Fixation of the glands implies advanced malignancy, and it is reasonable to suppose that a subsequent attempt at clearance of the axilla will only serve to disseminate the disease and to stir up trouble which, if left alone, might have remained dormant for a time at least. In my opinion, these cases are just as incurable by surgery as those with a supraclavicular mass. Pre-operative X-ray treatment may render them technically operable, but that is not the same thing as rendering them surgically curable. Patients in this group belong to Stage III, and not late Stage II. They are surgically incurable.

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Indications

In discussing the indications for pre-operative therapy, it is impossible, because of our limited experience, to lay down any hard and fast rules. We can say that its application is being extended in two directions :

First.—*Pre-operative X-ray* treatment is beginning to be used as an *alternative to routine post-operative therapy.* The use of X-rays pre-operatively for the type of case which has for so long more usually been given post-operative treatment is a development of special interest at the moment. No results of pre-operative therapy used in this sense have been reported from any country in figures which can be regarded as statistically significant. If the claims made for pre-operative therapy could be confirmed, such as higher dosage, greater radio-sensitivity of outlying cancer cells and reduced vitality of disseminated cells, then it might be better to substitute pre-operative therapy where post-operative is now used. Against this we have to evaluate the risk, if any, of postponing the operation while X-ray treatment is being given (four weeks approximately) and the skin is recovering (six weeks). We can only await the results of trials which are at present proceeding.

Second.—Pre-operative X-ray treatment is of particular advantage when it is judged that, because of shortage of skin, primary removal of the breast (and tumour) would leave a gap between the edges of the skin flaps.

A *shortage of skin*, although not invariably present, is commonly found :
  (i) When the tumour is large or the *breast unusually small* (small breasted women and males).
  (ii) When the tumour is attached to the skin over a wide area (or the skin is infiltrated over the tumour).
  (iii) When the tumour has ulcerated through the skin.

Because of this shortage of skin, primary mastectomy, whether it be simple or radical, is likely to leave a defect at the end of the operation between the edges of the flaps. Such a defect has two disadvantages :—

First, it can only heal by skin graft, or by granulations and scar tissue, which forms a patch vulnerable to subsequent post-operative therapy, and, *Second*, and more serious, healing is often protracted, so that the start of post-operative therapy is delayed sometimes to a point when its usefulness is open to question. If, by careful clinical assessment, we can anticipate such a defect arising, then we should give the X-ray treatment as a pre-operative measure. Delay in the healing of the wound from whatever cause it may develop subsequent to X-ray treatment and operation, has not the same significance as it holds up nothing except the ordinary convalescence of the patient.

Subsidiary Advantages of Pre-Operative X-Ray Treatment

The bulky tumour.—If the tumour occupies half a hemisphere or more, X-rays or radium alone are unable to deliver a lethal tumour dose simply

because of the physical fact of bulk of the growth and the limited tolerance of the overlying skin. The bulky breast is, however, commonly reduced in size by the X-ray treatment, and so made more manageable for operation. [Large tumours in the breast are not always attached to the skin and are not always as malignant as they look : this is because the rate of growth has sometimes been so rapid that the lump is noticed in the breast earlier than in the slower growing types, and because of its short duration, spread to the axilla may not have occurred.]

The widely attached tumour.—Wide attachment of the breast tumour to the skin and even infiltration of the skin, provided that it is not too widespread, will usually respond surprisingly to X-ray treatment. Subsequent mastectomy is carried out by some surgeons with a more restricted excision of skin—on the grounds that the skin has been sterilized—than would have been contemplated if preliminary irradiation had not been used. Pre-operative irradiation *does not in any way absolve* the operator from still adhering to the principle of excising a wide area of skin clear of the growth. The point is that once the course of therapy has been given delay in healing has less significance.

The ulcerated tumour.—Primary radical mastectomy is absolutely contra-indicated in the presence of *moist* ulceration of the breast because of the risk of widespread infection of the tissue planes opened up in the course of the dissection. By giving pre-operative X-ray treatment, the moist ulcerating growth is frequently dried up, which reduces the risk of subsequent sepsis.

Reassessment after Preliminary Irradiation

One month after the termination of the course of X-ray treatment, the patient returns for reassessment. Contra-indications to operation in the form of metastases may have developed in the interval. The chest, spine and pelvis are re-examined radiologically and palpable secondary deposits in the abdomen and pelvis are excluded before proceeding to implement the original plan of treatment.

Combined Pre-Operative and Post-Operative Therapy

Fractionated Course

It has been claimed, notably by Ahlbom (1941), Roden (1944), and Pfahler and Keefer (1947), that the best results with irradiation in carcinoma of the breast are to be obtained by dividing the course into part pre-operative and part post-operative exposures. In this country the method has not been widely practised, and there are no statistics available. The view is held by some distinguished radiotherapists that by splitting the course the summation effect is reduced or may even be rendered useless. It is certainly true to say that the administrative difficulties are doubled, whether the effect is halved or not. If delays in post-operative convalescence should occur, these further complicate the picture and interfere with the radiotherapists plan of treatment.

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Intensive Course

It has been suggested that in order to meet the main criticism of pre-operative therapy, that is the delay in operating, that instead of the usual fractionated course of therapy spread over weeks, an intensive course should be given which can be completed in a matter of days. There are difficulties in achieving this desideratum. In particular, in order to avoid any possibility of burning the patient, the therapist has to play for safety by giving a submaximal dose, which presumably cannot be as effective as treatment which is taken to the limit of skin tolerance. A variation of this procedure is at present under trial in at least one radiotherapy centre. A single exposure is given pre-operatively of the order of 800 to 1,000 roentgen with the surgeon operating on the following day. By operating as early as this it is hoped that primary union of the skin flaps will have taken place before the irradiation reaction sets in. Post-operative fractionated X-ray treatment is then given in the usual way to the limit of skin tolerance. There are no statistics available.

The object is to get as it were the best of both worlds. The pre-operative single exposure is a form of shock tactics intended to do widespread chromosome damage, as opposed to attacking the nucleus in the premitotic stage, which is said to be the main advantage of the fractionated method of treatment. No useful comment can be made until there has been further experience of the method.

SURGICAL TREATMENT

The accepted teaching for many years has been that radical mastectomy was the best available surgical measure for the treatment of Stage I and II cases. This established practice has recently been challenged, and a plea has been put forward for more conservative surgery.

In 1941 an important experiment in the treatment of cancer of the breast was launched in Edinburgh. It was agreed between the surgeons and the department of radiotherapy of the Royal Infirmary to try out a uniform of treatment for all operable cases, and in addition to pool this large volume of clinical material for statistical analysis. No doubt a number of factors contributed to this decision, not least amongst them, the common knowledge that three-quarters of all patients presenting with cancer of the breast having metastases in the axillary nodes were dead in five years' time. The wish to improve this melancholy state of affairs, coinciding as it did with a spell of a rather higher mortality than usual for the radical operation, gave the desired opportunity to an expanding and active department of radiotherapy.

The method decided upon was simple mastectomy followed by post-operative irradiation to the chest and the *undissected* axilla. It is interesting to observe that this method is precisely the same as that of Keynes, with the difference that X-rays are substituted for radium and that in addition, the subpectoral group of glands are removed at the same time as the simple mastectomy, if they are accessible.

In this method Stage I cases are included as well as those with palpable axillary nodes (Stage II). The view is taken that if the disease has spread to the axilla then surgery will only serve to disseminate it still further and that if the disease is confined to the breast then dissection of the axilla is unnecessary. The most advanced cases are treated by irradiation alone. Encouraging results are claimed in all stages of the disease.

Survival-Rate of all Operable Cases. (Stages I, II and, III) Corrected for Post-Operative Deaths (McWhirter, 1948)

Period	Method of Treatment	5 Years
1930-34	Radical mastectomy only	35·6%
1935-40	Radical mastectomy+Post-operative radiotherapy	44·0%
1941-45	Simple mastectomy+Post-operative radiotherapy	56·0%

So far only a limited number of cases are available for 5-year survival-rate analysis. The claims of the method, apart from improved results in all stages, are that the procedure is almost without operative mortality, with less morbidity, without the complication of the swollen arm and that dissemination of the disease, because the axilla is not disturbed, is less likely than with the radical operation. The criticisms of the method are much the same as those already mentioned as applying to the radium technique—in particular, the persistence of active malignant cells in the axillary glands after the termination of treatment.

That they do persist, at least for a time, has been proved by carrying out a radical mastectomy after a full course of pre-operative irradiation and examining the axillary and breast material so obtained. (Figs. 1, 2 and 3.) Individual experience is now considerable, and the persistence of malignant cells in the axillary glands in approximately 60 per cent. of patients treated with irradiation alone is probably not an exaggeration, Adair, 92 per cent. (1940), Richards, 65 per cent. (1948). In this respect, experience appears to be in line with that following the use of radium. The following are illustrative cases in which the residual tumour in the breast still contained active malignant cells on histological examination, and cancer cells were also present in the lymph nodes. The histological reports on the lymph nodes made by Dr. T. Crawford of St. George's Hospital, were as follows :—

Case 1.

Mrs. F. Age 63. Carcinoma mammæ (right) with fixed axillary glands. Pre-operative irradiation : lesion dose 4,300 r., 15 treatments. Radical mastectomy 26 *weeks* after termination of X-ray treatment.

The *axillary glands* are largely replaced by adipose and fibrous tissue, but here again some collections of malignant cells can be found. The cells appear somewhat degenerate, but otherwise have the same features as those in the breast tissue. (Fig. 1.)

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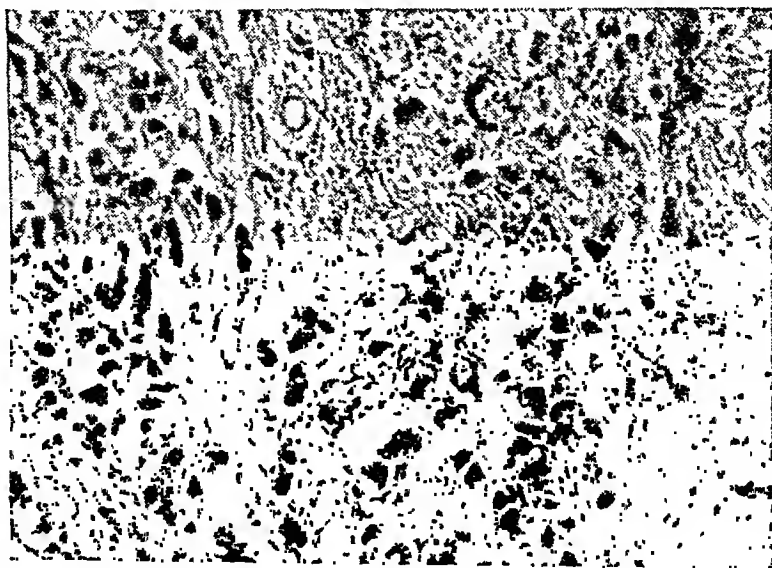
FIGURE 1
Post-irradiation Mastectomy Specimen
Axillary node showing presence of malignant cells 26 weeks after termination of
X-ray treatment
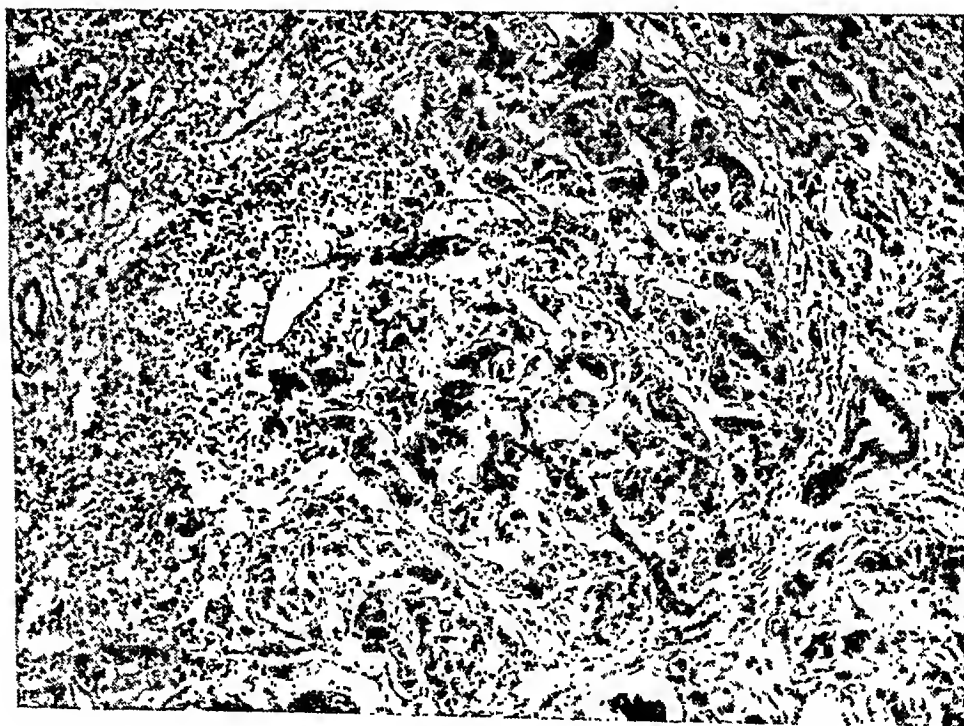
FIGURE 2
Post-irradiation Mastectomy Specimen
Axillary node, showing presence of malignant cells 9 weeks after termination of
X-ray treatment

Case 2.

Miss L. Age 30. Carcinoma mammæ (right) with fixed axillary glands. Pre-operative irradiation. Lesion dose 3,500 r. Radical mastectomy 9 *weeks* after termination of X-ray treatment.

The *axillary glands* are heavily infiltrated with tumour. Although there is considerable evidence of damage to the cells and surrounding tissue from the radiological treatment, there is no doubt that most of the cells remain viable. (Fig. 2.)

FIGURE 3
Post-irradiation Mastectomy Specimen
Axillary node showing presence of malignant cells 52 weeks after termination of X-ray treatment

Case 3.

Mrs. Y. Age 30. Carcinoma mammæ (left). Axillary glands not palpable. Local excision of tumour followed by irradiation. Lesion dose 3,500 r. Recurrence 12 months later. Radical mastectomy 52 *weeks* after X-ray treatment.

One enlarged lymph *gland* was detected amongst the axillary fat, and this was found to be extensively invaded by the growth. (Fig. 3.)

The protagonists of X-rays say, and hope, if the irradiated tissues are not disturbed by operation, that the cells will eventually either disappear or be rendered harmless by fibrous encapsulation. Those in favour of clearance of the axilla by operation contend that X-rays are only a 'holding' technique and that crops of recurrences or dissemination

must be expected between the fifth and tenth years. Time alone will show who is right. The crux of the matter is : can irradiation methods in Stages I .and II (the only stages in which radical mastectomy is still employed), restrain the local growth and spread of carcinoma in the axilla more effectively than the surgeon by his operative clearance ? We do not know the answer to this question. _ We can only point to the success surgery has had, and is still having, in Stage I, and say that we believe in favourable cases that surgery is a more thorough and more certain method of clearing the cancerous axilla. It is not yet possible to assess the Edinburgh experiment. At this stage we can do no more than compliment the workers there and wish them well. Ten-year survival-rate figures should be available in 1951.

The axilla—dissection or non-dissection ?—In the meantime, we have to make up óur minds what attitude we are going to adopt in the treatment of our operable patients in regard to dissection or non-dissection of the axilla.

Stages I and II (Early)

Radical Mastectomy. Radical mastectomy combined with radiotherapy should, for the present, remain the sheet anchor in the treatment of the potentially early case until an unequivocally superior method has been demonstrated over a 10-year period, and for these reasons :—

First.—No other known method has yet produced results as satisfactory over a similar term of years. In the series of Stage I cases published by Gordon-Taylor (1938), and in the Leeds series of gland-free cases (Ministry of Health, 1926), 84 per cent. and 91 per cent. respectively of the patients operated upon were alive ten years later. These figures approximate very closely to the chances of survival amongst the general population in the same age periods, and must, therefore, be regarded as very satisfactory. Until such evidence is available it is difficult to see how the conscientious surgeon can abandon the operation of radical mastectomy in this group of patients.

It is tempting to. be diverted by an attractive hypothesis,—and, while all surgeons must yearn for progress in this field, it might be a retrograde step and would certainly be a premature one to jettison radical mastectomy until more conclusive evidence is available.

Second.—The operation of radical mastectomy is based on sound pathological and surgical principles. The operation of local mastectomy for cancer is a violation of these principles because it cuts directly and across the path of spread of the disease. If results prove that the procedure is justifiable, well and good, but until it has proved itself and been substantiated by others we cannot turn our backs on the accepted teaching and accumulated experience of the last 50 years.

Third.—There is no series available of breast cancers treated by a combination of *modern* radiotherapy and *modern* surgery for comparison with the Edinburgh statistics, which therefore can only be contrasted with

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3.

out-of-date methods and a radical operation which carried with it a greater mortality and morbidity than it does to-day.

Fourth.—The general standard of radiotherapy throughout the country is not yet high enough to implement the Edinburgh procedure, even if this was thought desirable. Widespread adoption of simple mastectomy at the present time would be a disaster, and is the last thing that workers there wish to see. The patients would be the first to suffer, primarily from inadequate treatment, and the method itself would lose the reputation which it may well be on the way to making.

Lastly.—The continued presence of living cancer cells in the undissected axilla despite X-ray therapy has been demonstrated. This is bound to leave a feeling of disquiet and insecurity in the minds of all who are anxious to arrive at a proper solution to this problem. The danger of these residual cells may be exaggerated, and be more potential than actual, and we may find that their clinical behaviour belies their sinister histological appearance, but the possibility of their recovering their activity cannot be ruled out. While this possibility would seem to be a reasonable risk to take in the more advanced stages of operable carcinoma (late Stage II), where the hazards of operation are increased and the prospects of cure reduced, it cannot be so regarded in the earliest stages of the disease, where so far as our information goes at present, the radical operation still offers the best opportunity of clearing away all malignant tissues from the axilla.

Stage II (Late)
Simple Mastectomy and Irradiation of the Undissected Axilla

Is there any place at the present time for the treatment of operable cancer of the breast by simple mastectomy and irradiation of the undissected axilla ? I believe there is in *late* Stage II. The case for simple mastectomy in late Stage II rests on the assumption that the disease is no longer purely extrathoracic and that irradiation of the cancerous axilla is less likely to disseminate and more likely to control the disease than surgery.

It would seem that while some surgeons are opposed to any form of compromise and feel that in all operable cases, simple mastectomy is a betrayal of the radical operation, there are others who feel just as strongly that the radical operation should not be applied as a routine rule of thumb procedure simply because the patient is classified as belonging to Stage II. All patients in Stage II are not equally at the same pathological stage in their illness : indeed this group ranges over the whole course of the disease, and some patients are at one end of the scale and some are at the other.

Adverse factors

What criteria are there to guide us towards separating the later cases from the earlier ones ? Size alone is not the criterion, because we know that the swelling no larger than a pea may already have sent its metastases

to the axilla. Ulceration alone, though not usually regarded as a favourable sign, cannot always be regarded as an unfavourable one, for in some ulcerating cancers the growth seems to spend its strength locally rather than in metastasising to the axilla. I refer to such factors as *age, site, rate of growth* and *extent of skin involvement.* Experience alone can guide us here and opinions will vary widely but, without prejudice to such revision of these factors as may be dictated by future experience or developments, I think the time has come when a conservative mastectomy without dissection of the axilla should be seriously considered—assuming first-class radiotherapeutic services to be available—if two (or more) of the following adverse conditions are present : rapid growth, wide involvement of skin, age over sixty-five years, and possibly a peripherally situated tumour, more particularly if it is on the inner side. (The significance of site in prognosis appears unsettled. It is claimed by Bartlett (1933) and Hawkins (1944), that inner hemisphere tumours have the worst prognosis, but Lane-Claypon (1928) in the Ministry of Health survey, and Perry (1926) found no evidence that the prognosis varied with the site.) Time may prove that one or more of these factors should be withdrawn and others more serious substituted, of which the anterior mediastinal gland factor, to which our attention has recently been drawn by R. S. Handley (1947) may be one of the first.

I should like to record my grateful thanks to many friends, both surgeons and radiotherapists, who have discussed this subject with me, particularly to J. Jackson Richmond, F.R.C.S., of St. George's Hospital.

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THE SURGICAL SIGNIFICANCE OF SOME SO-CALLED SIMPLE TUMOURS

Lecture delivered at the Royal College of Surgeons of England

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by

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LET ME BEGIN by describing my first encounter with a simple tumour. It was a nice simple lipoma on the back of a healthy looking man. Alas, the differential diagnosis, in which the icebag test was not included, was not fully explored prior to operation, when to the dismay of the teacher there was revealed a cold abscess—a tumour yes, but not a neoplasm. Admittedly the bulk of the tuberculoma is composed mainly of swollen coagulated necrosed tissue and fluid, but some of the mass has been formed by the proliferation of cells of the part as well as by incoming cells. More obvious proliferation is seen in the granuloma pyogenicum ; this sometimes grows at a most alarming rate and on an infant's face, especially if the parents be medicals, the pre-operative diagnosis is inevitably sarcoma. Occurring about the finger nail, it produces a horrible looking growth with a differential diagnosis made particularly difficult because such conditions as subungual melanoma have to be remembered.

Fortunately the granuloma pyogenicum responds in a remarkable way to radiotherapy ; this is a practical help but we are still left wondering about the basis of the rapid growth. Histologically the picture is one of capillary angioma plus pyogenic infection but it is probable that the angiomatous proliferation is the secondary and not the primary change. The more serious form occurring in the nose, the so-called granuloma malignum, has been attributed to a particular staphylococcus possibly in combination with a streptococcus (Stewart, 1933) although other writers obviously consider this growth as a malignant neoplasm of uncertain origin (Dempsey, 1933). Meanwhile let us diverge for a moment.

It is known that a malignant neoplasm can arise in granulation tissue ; Pack and Anglem (1940) quote one arising in uninfected granulation tissue in relation to a hæmatoma and I have seen a similar lesion in the breast of a young man—a blow on the breast was followed by a large swelling, presumably hæmatoma, which diminished slowly. Some four months after the injury, when almost gone, it was replaced by a new and painful swelling, which was removed by wide excision. Histologically this showed remnants of hæmatoma with phagocytic reaction of gross

degree ; most of the pigment was intra-cellular. At the periphery there was a new tissue of soft fibromatous type which was obviously invading the surrounding fat ; despite the histological findings, he is now, three and a half years later, well and free from any sign of disease. This sequence recalls the changes described by Browning *et al* (1936) in the mouse, where a depôt of a trypanocidal styryl compound in the subcutaneous tissues elicits an active surrounding phagocytic reaction, followed in turn by the development from these phagocytes or their precursors, of a sarcoma. To return to the nasal granuloma it is possible that some observers have had cases in which a malignant growth, like these just discussed, has arisen secondarily and, by so doing, has cast suspicion on the exact nature of the pre-existing lesion. One is apt to forget that the onset of malignancy in a lesion is not proof that the earlier lesion was itself a neoplasm. Some such sequence may well be the explanation of the vagueness of the conception generally held about this condition.

Philosophically, of course, the really surprising thing is that the proliferative activity of granulation tissue in the healing of wounds is so consistently restricted at the right level. One thinks of the rare failure of the retarding mechanism, when the brakes don't work in time, namely, the formation of keloid ; although in fact we may well pause to wonder why the keloid, having overshot the mark, then usually stops. None the less the power of proliferation is still there and is presumably under slightly more tension than normal, in that sarcoma occasionally arises in a keloid. One example, observed personally, arose in a keloid which had been present for forty years at the site of burn in infancy. It need hardly be said that a keloid would scarcely fit the definition we hope to coin for a simple tumour.

But we are not yet escaped from the boundary zone between infection and simple tumour. The molluscum contagiosum is occasionally removed by the young surgeon lacking the dermatological knowledge which, judging by one's experience as a hospital pathologist, is too often disdained by surgeons, to the disadvantage both of themselves and their patients. With such knowledge, the diagnosis of molluscum is fairly straightforward. There is now little doubt about the infectious nature of this odd little growth and histologically it seems to have nothing to do with neoplasm as we understand the term.

More difficult to apprehend correctly are the ordinary warts of the juvenile skin ; doubtless many of you have had your own personal experience of these. One boy in whom I had a particular interest was, along with his brother, afflicted by a remarkable efflorescence of these on the hands. Over 200 warts were present, and on the forefinger of the right hand 91 individual tumours could be counted. Doubtless it was from this site that there was transmitted the cause of a daughter tumour which appeared on the point of the nose. Maternal concern led to the electro-coagulative destruction of the nasal protuberance and within a week or

two thereafter the digital growths thawed away, the skin was smooth again and the various ruptures and cracks all healed over. One can hardly claim that the success of the therapy was anything other than coincidental ; after all it is known that these crops of vulgar warts do eventually disappear, presumably as the result of an immunity reaction. The many therapies that are advocated by the old wives are, in this disease, probably quite without effect.

Certainly the popular application of early morning spittle is likely to be of little value if the virus involved is the same one as causes the multiple papillomata occurring on the larynx of young people. This, in virtue of its situation, is of course a much more serious condition and although the growth may disappear spontaneously, generally doing so about puberty, recurrence after surgical removal is common and often extensive. Tracheotomy may be necessary and Tilley (1940) describes a case needing frequent re-opening of the wound ; in all, this small boy endured 45 surgical interventions, and had to wear a canula for many weeks, the condition meanwhile spreading up the posterior pharyngeal wall into the nasopharynx. Then, within a fortnight, all disappeared and did not recur.

The only example I have seen was a boy of 12, almost choked by growth, from whom Dr. Fulton Christie removed the exuberant masses. Histologically this had the picture of simple squamous papilloma. Two months later recurrence was obvious, but radiotherapy by Dr. Scott Park for four days (1,000 r), led to disappearance and no further recurrence (over 14 months). Radiotherapy is apparently not always successful but certainly in this condition, seemingly rarer than it once was, it offers more success than early morning spittle.

Into the same puzzling group one would be justified in putting the venereal wart. The tuberculous wart, named, perhaps unfortunately, lupus verrucosa, is more obviously a reaction to a known lesion. This occurs on the hands of cattlemen and the like, and the two cases I have seen were both concerned with the killing of cattle. One showed a small zone of hyperkeratosis related to an underlying tuberculous granuloma ; the other had a large zone of very warty reaction.

Another peculiar form of hyperkeratosis is the comparatively rare condition of Hairy Tongue in which long filiforms of keratin are seen with a coating on each of these " hairs " of fungal growth. The fungus may be coloured and the wretched patient have a tongue like a thick pile green or purple carpet.

In case you should imagine the boundaries are clear-cut somewhere in this subject, I would recall the extraordinary appearances of overgrowth of bone in the infra-orbital region in the condition of Goundou. This is believed (Botreau-Roussel, 1925) to be due to yaws, and yet, as Stannus (1947) observes, the extraordinary illustrations published by Botreau-Roussel can be matched in this country by cases of leontiasis ossea. Certainly the leontiasis case I have seen, a museum specimen, was quite

as florid as the West African lesions; unfortunately syphilis, although
unlikely in this case, was not tested for. Paget himself thought the maxillary
osteoma was probably not a neoplasm. None the less some of the simple
" nasal osteomata " are probably, in fact, epiphyseal sequestrations of the
frontal bone (Handousa, 1940), comparable with those seen in the long
bones.

From these infective conditions which mimic simple neoplasm, it is
but a short step to the traumatic condition as seen so characteristically
in the dental fibroma which would usually be more accurately described
as a denture fibroma, and to the " simple tumours " of metabolic origin,
for example, the multiple xanthoma. This type of tumour may be accom-
panied by other obvious evidences of upset cholesterol metabolism
(Brunschwig, 1939) and yet, particularly in relation to joints and tendons,
the tumour may be single and apparently unaccompanied by evidence
of metabolic upset. The histological pattern of the different types can be
extraordinarily similar. The confusion here probably arises because the
neoplasm of synovia may occasionally by chemical chance contain
fatty material in its cells, and only rarely are the synoviomata frankly
malignant, so seldom indeed, that some writers have postulated a granu-
lomatous rather than a neoplastic nature.

Also, as it were, metabolic, and in this example surely related to the
endocrines, is the fibromyoma of the uterus; this so-called tumour is
readily induced in guinea pigs by œstrogens although not as a rule in rats
or mice (Burrows, 1942). None the less one would hesitate to relate the
fibroma in the intestine to an endocrine imbalance. To some such
imbalance it seems fairly certain we should ascribe most examples of
fibroadenoma of the breast and the common simple hypertrophy of the
senile prostate. The fact that malignancy *can* arise in the uterine fibroid,
in the fibroadenoma of breast or in the enlarged prostate does not mean
that the commonly met state of affairs is a true simple neoplasm.

Another of the difficulties in defining the boundary between the simple
and the malignant tumour lies in that factor so often neglected by the
pathologist, the time factor. For example, at the Memorial Hospital in
New York (Pack 1939), it has been found that epithelioma of the hand
in the elderly takes about three years from first appearance before it
produces metastases. The Marjolin ulcer, the supervention of an epithe-
lioma in a burn scar, takes on average 43·3 years to arise. Not that this
removes clinical worry, for the variation in time of onset ranges down
to three months. Of subungual melanoma Hutchinson (1886) said " there
is much greater hope of delaying the progress of the disease by operation
than exists in most other forms of melanosis." There is no doubt that
some acceptably malignant tumours have a peculiar way of going slow.

What then are we going to say of the tumours that not only go slow
but even regress, the uterine fibromyoma after the menopause, the
osteoma which in many cases ceased to grow after puberty, and, having

a small stalk, may cure itself by sloughing off, the multiple exostosis (with a family history in two-thirds of the cases) and even the so-called self-healing squamous carcinoma in which the keratinised remnants of the tumour are seen being dealt with by phagocytes ?

The slow-growing tumour has in the past made its claim to be called benign, for example, the rather uncommon carcinoma of the trachea. The two cases I have seen were found at necropsy, and like some of the others reported, one of these had produced no metastases and very little local invasion. It would have been a most suitable case for a bold surgeon, if diagnosed, and Chevalier Jackson's aphorism (1945) is worth recalling : " All is not asthma that wheezes." The histology of both these growths is strongly reminiscent of the salivary growths occurring in the palate, and quite a number of the reported cases (Culp, 1938) have been described under the various vague terms which used to be applied to parotid tumours. A curiously similar histological picture has been seen in a recurrent carcinoma of the orbit and in a tumour from the skin of the groin, both of which I mention because Paget (1876), referring to the type of tumour described by Billroth as a cylindroma, records examples in the parotid, in the orbit and in the loin.

The parotid tumour itself can be slow-growing, although its simplicity is, as it were, reduced by its inaccessibility. Paget (1876) quotes with commendation of Hunter's skill, one such tumour which John Hunter removed, measuring 9 in. × 7 in. and weighing 9 lb. While in this region one may mention the adenolymphoma, an apparently completely benign lesion of the parotid, which that invariably benign pathologist Professor M. J. Stewart of Leeds once implied should be recognised by any intelligent surgeon (Carmichael, Davie and Stewart, 1935). One of several intelligent surgeons known to me was studying these tumours and on the lookout for another, when he was misled by a cystic form of the more usual parotid tumour !

The term "mixed tumour" is going out of favour—and justifiably! In one salivary tumour of lip given to me by Professor D. F. Cappell, the tumour cells had burst into the tissues, and, so far as one is justified in believing what one sees through the microscope, the product of the cells seemed to be diffusing out further into the tissues. Close to the tumour cells this looked like oedema fluid which, with special staining, gave the colour reaction of mucin but distally the appearance changed gradually into what was, on morphological and tinctorial grounds, cartilage. The transition was so gradual that to the observer it seemed that the resemblance to cartilage must be fortuitous. None the less the tissues themselves must have been deceived, for there had been formed in this apparent cartilage, what was unmistakable bone.* Similar formation of bone in " cartilage " in a salivary lip tumour was noted in his time by Paget (1876).

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*This histological section seems to say that saliva injected into connective tissue persuades (organises) it into becoming cartilage.

Nevertheless non-progression is not necessarily simplicity. One only has to recall Bowen's disease, in which, although restricted within the epithelium's narrow plot of ground, the condition is cytologically malignant and a squamous carcinoma lies confined, like a coiled spring, within the epidermis. One may well wonder why it does not more often spread laterally as the intra-epithelial malignancy does in Paget's disease. Admittedly the Bowen's case eventually breaks out, but some of the other long-duration growths can boast a prolonged story without any such sad end. The horn of the Widow Dimanche (Bland-Sutton, 1894) was not produced in a day and Paget (1876) quotes a massive fibroadenoma of the breast observed for 30 years. This alarming looking growth, known also as Brodie's serocystic sarcoma, or as Müller's pseudo-sarcoma phyllodes, is generally benign despite its tendency to fungate horrifically.

Apart from slowness of growth which permits the cogitation of the medical and the pre-operative handling of the patient (it is a significant point, realized last century, that the so-called simple tumour not infrequently comes to notice because of secondary infection), certain tumours have, as it were, become more benign in virtue of their greater accessibility. For this we owe a great deal of the credit to our anæsthetist colleagues, whose technical advances in the last twenty years we ought, as medicals, to acknowledge with gratitude. It is interesting how modern refinements and the setting up of special clinics, for the specialists thus distinguished, have brought to light conditions which are not so rare as they were once thought to be, for example, the bronchial adenoma or the intra-thoracic neural tumours.

Of course accessibility varies with the surgeon's own idea of his skill, and one example studied of a carotid tumour, a tumour said never to go malignant, (Willis) proved fatal for the patient, a young man, through its too intimate relationship with the artery of the same name. Recent work (Lahey and Warren, 1947) suggests the value of a diagnostic biopsy before deciding on removal if the artery is likely to be involved.

Despite the advances in surgical technique, surgical removal may prove, as we call it, incomplete. The most striking example of this is, of course, the recurrent fibroma, the recurrent fibroid of Paget; this has to be distinguished from the fibroma of the rectus sheath, the desmoid tumour, which is a tumour mainly of parous women, and may possibly have some relationship with hæmatoma of the rectus. Histologically the recurrent fibroid seems no more than a cellular fibroma and in one case studied over nineteen years the cytological appearances were still short of malignancy; none the less its clinical behaviour demands that we recognize it as a low-grade sarcoma of the dermis.

We are still not getting much nearer a definition of a simple tumour, and such obvious delimitations as " non-metastasizing " cannot very well be squared with the recurrent fibroid, nor, indeed, with rodent ulcer.

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This latter tumour is itself problematical enough for a series of lectures, and although I am not prepared to push the thesis, one cannot entirely ignore the suggestion that most at least of the facial rodent ulcers are situated on the embryonic lines of fusion (McFarland *et al*, 1935).

Indeed, the whole question of sequestration and developmental displacement is, perhaps, the territory in which it is most difficult to find a dividing line. Take for example the hæmangioma ; of 996 angiomata at the Memorial Hospital, 66 per cent. (660) were present at birth (Ewing, 1940), and in a review of 318 cases (Geschickter and Keasbey, 1935), one-third were in children under 10. Most of these so-called tumours therefore appear to be congenital and it has been suggested that the termination should be altered, to express the widespread doubt as to the neoplastic nature of these abnormalities and I for one quite like Robertson's (1939) term, hæmangiecton.* Histologically some of these hæmangiectons, especially the cavernous type, look the most placid and innocent things, and yet the cerebral type can, as in one case personally studied, lead to death in convulsions in under eight hours.

The dermal type can also be much more obtrusive than its histological appearances would suggest; thus it may produce a clinical picture of intense paroxysmal and travelling pain which is more usually indicative of a glomangioma or, as we may now call it, a glomangiecton. This painful subcutaneous tubercle as you may remember is characterized histologically by the presence of glomus cells, believed to be modified muscle cells, which are a normal constituent of the arterio-venous shunt in the dermis. A fair number of the reported glomangiectons can be clearly related to an apparently causative trauma, and most observers have accepted the relationship (Lendrum and Mackey, 1939). No such relationship, however, occurs with any significant frequency in the case of the rather comparable tumour, the myoma cutis, the third small dermal tumour of adult life which can underlie the dramatic clinical picture so magnificently described by Wood of Edinburgh in 1812.

Along with the hæmangiectons of childhood we may surely group the lymphangiectons, including the hygroma. The lymphangiecton of adult life, such as that in the epididymis, may well be the result of a mechanical retention as indeed are numerous conditions we are pleased to call simple tumours, such as the sebaceous dermoids and many of the cysts. Of these I may mention for interest the gas cysts of the intestine. There was a specimen in the museum here ; it was from a hog and was sent by Jenner to Hunter, and to complete its fame I need only add that Cavendish himself reported on the contained gas: " a little fixed air, and the remainder not at all inflammable, and almost completely phlogisticated." Sir James Paget's comments are worth quoting:" Surely never were the elements of

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*The *ectasia* or widening may not be obvious in the individual vascular channels of the lesion, as for example in the paucivascular form of the glomangiecton. None the less the duplication of channels constitutes an enlargement of the vessel which would normally occupy the site.

an inductive process combined in such perfection ! Jenner to observe ; Cavendish to analyse ; Hunter to compare and reflect," (Paget 1876). Of the three human cases I have seen, two had severe pyloric stenosis.

Another so-called tumour which is frequently an architectural mishap is the lipoma, especially the small ones, for example, in the renal cortex. On the other hand the diffuse variety as in lipomatosis of the neck is thought to be metabolic in origin and its rarity to-day may be a reflection of the higher proportion of water in the solvents we imbibe. A diffuse type of lipoma is occasionally seen in a limb but we would scarcely be tempted to think of it as metabolic. Lipoma is so often our mental proto-type of a simple tumour that we are apt to forget how it can fox us clinically ; a sacral one may overlie a meningocele, in the groin lipoma may mimic a hernia, while, as in the specimen in this museum of such a tumour arising at the base of the tongue, the simple lipoma can cause sudden death (Choyce, 1932).

Possibly the papilloma of rectum in the child is also a displacement abnormality. I was led to this possibility by the finding of Paneth cells in two such cases. Normally, as you may remember, there are no Paneth cells in this part of the alimentary canal ; they are, in man, essentially cells of the small intestine. My interest in this cell arose during the study of a papilloma of the gall-bladder. This growth was formed of small-intestinal epithelium and behaved in a way that could well be expected of such epithelium (Kerr and Lendrum, 1935-36). From a cholecystostomy wound there poured out almost pure saline up to a rate of $7\frac{2}{3}$ pints in one 24-hour period with a sodium chloride content of 0·8 per cent. Thus, this growth—not 3 in. in diameter—effectively dehydrated the patient by its extraction of water and chloride and this latter at a higher concentration than in the serum and at times when the kidneys, conserving chloride, were allowing none to pass out in the urine. My surgical colleague, A. B. Kerr and I decided this growth was a true heterotopia and I may add that the distinction between heterotopia and metaplasia is not always easy. This same problem arises over the so-called sweat gland adenoma of the breast. A study made of this type of change some years ago seems to show that it resembles not the ordinary sweat gland but the apocrine glands, which are specialised sweat glands with a peculiar granule-containing epithelium (Lendrum, 1945).

The apocrine glands, which have some peculiar connection with the sex mechanism, occasionally form an adenomatous mass in the axilla, or the vulvar or perianal region. Another interesting feature of these glands, shared with the breast, is the presence of the so-called myoepithe-lium. This is a layer of strap-like material with the colour reaction of smooth muscle, lying between the glandular epithelium and the basement membrane.

You will have noted that I have omitted the whole debatable group of non-malignant tumours of the endocrine glands, and by this time you

may well be feeling that even, despite their absence, the exact definition of a simple tumour is obviously going to be impossible and be tempted to ask if it really matters.

After all, one removes the so-called tumour, and if the pathologist says it is simple then so much the better. The removal is done partly to obtain a diagnosis which could not otherwise be certain, and in most cases there is no strong biological argument against removal. I would certainly agree with you thus far, although to continue on a practical note may I, on the grounds of experience, plead for the most scrupulous handling of pigmented tumours and the widest possible margin of excision ; the growth may be found on microscopical examination to be merely a simple melanonævus but too often, as a result of parsimonious surgery, I have found a frank melanoma with neoplastic invasion up to the edge of the tissue removed. Also, please consider papillomata of the bladder, papilloma of the adult tongue and of the pinna of the senile ear as at the very least locally malignant (Charteris, 1948), and in the case of a recurrent fibroid undertake the most drastic excision possible !

To return to your point, an enlarged cervical lymph node seems an obvious candidate for histological investigation although, I regret to say, operation is occasionally carried out before instead of after an examination of the white cells of the blood. The number of biopsy specimens removed before a Wassermann test has been reported is in part explained by the convenience of taking both specimens at the same out-patient session. None the less this is bad surgery, and to omit the serological investigation is even more culpable. I have seen two examples of subcutaneous gumma from the elbow region beautifully and completely removed by young surgeons whose error of omission was possibly due more to forgetfulness than to innocence of mind. It is a pity that the pathologist, with a section of the gland to look at, is not always able to give the prognosis ; for example in Brill's disease, multiple follicular lymphadenopathy, it is by no means clear yet whether deep therapy is really necessary.

There is little doubt that all of you would give a guarded prognosis on first meeting a swollen cervical gland and yet be tempted to give a good one for a tendon sheath tumour or for a giant cell tumour of bone—the osteoclastoma. Having seen the malignant form of both, revealed in the laboratory, one would be hesitant to give a prognosis on the clinical findings alone.

May I seize this moment to put before you some points about the guarded prognosis ? The pathologist is often reputed to be the surgeons' only critic, but true or not the young surgeon will learn a lot about the way of a surgeon if he works for a spell as a hospital pathologist. First let me quote the statement of Minnermos (600 B.C.) preserved for us by Stoboeus who quoted it as still apposite in A.D. 500 : " There are doctors who, to show their worth and to be sure of an excuse, made bad seem worse and of the worse make a disaster." This ancient maxim is one of many

interesting and intriguing things in " For and Against Doctors " by Drs. Hutchison and Wauchope. The guarded prognosis can only too easily become a habit, and like habits of the mind, it becomes widespread and incurable. The surgeon who over the years has been economical and accurate in his use of the guarded prognosis, acquires a reputation with at least one inestimably valuable result, the production among practitioners and patients of confidence in his judgment. One can hardly measure the aid this gives to his therapeutic efforts. For the surgeon to cry wolf is unwise ; on the other hand to be scared by a goose is pathetic, and one thinks sadly of the surgeon who refused to operate because he had wrongly assessed the tumour as less benign than it actually was. The simple myoma or fibroma of the stomach can cause steady slight bleeding, and radiologically, if the technique be short of the best, can look so like carcinoma of the stomach that it would have been left alone by some of the older generations of surgeons. The surgeon of to-day, supported by the modern skill of radiologists, gastroscopists, biochemists and anæsthetists, seems to take a more sanguine view of gastric surgery. One example of gastric myoma in my own series came to operation because of violent hæmorrhage : histologically it showed a small ulcer crater on top of an apparently simple myoma, but within two years this young woman had a peritoneum full of tumour. The alimentary leiomyomata are a family, as Professor Willis observes, with occasional black sheep.

Another tumour reckoned as unsuitable for operation until fairly recently is the extraordinary hyperostosis due to meningioma. Although not easy, total removal of the involved bone *and* the underlying meningioma has proved in skilled hands gratifyingly successful (Cushing and Eisenhardt, 1938).

Finally, before recalling our journey round the periphery of the so-called simple tumour, let me quote from Professor Willis' stimulating new book on the Pathology of Tumours : " The clinician's first demand of the pathologist who examines the tumour he has removed is : ' Is it innocent or malignant ? ' This habitual query has engendered the notion that every tumour must be either innocent *or* malignant. A more enlightened modification of the question and one which pathologists should encourage clinicians to ask is : ' *How* innocent or malignant is this tumour ?' ."

Thus, to recapitulate the wanderings we have undertaken, I think we may say that we have found it difficult to define the boundary between the lesions we know to be infective in origin and those we are tempted to accept as simple tumours. We can exclude fairly definitely from our tumour group some things which our forefathers accepted. We have also learnt that the onset of malignancy in a lesion does not necessarily mean that the original lesion was a simple neoplasm.

We have agreed to exclude changes which are traumatic in origin or metabolic—involving simple chemicals or endocrines. We have recognised

the difficulty of our boundary commission when faced by the very slowly growing tumour or by the incarcerated neoplasm (as in Bowen's disease).

We have had to accept the fact that some tumours were, in the past, virtually malignant because anæsthetic and surgical skill could not in those days provide a safe removal. We have looked at the displacement abnormalities and again found that we had to refuse admission to many of them—some of these being heterotopias, others partial failures in embryonic architecture, others again mechanical upsets of adult life, like many of the cysts.

We have avoided stirring the muddy waters of the so-called adenomata of endocrine glands, although I imagine you will agree that most of these are not true neoplasms. Yet somehow I feel we are scarcely ready to define the simple tumour.

Indeed, all I seem to have to offer is a series of exclusions, but these will, I trust, be of mental value to you in the future when you are tempted to harden your knowledge into definitions. The surgical significance of these various lesions I hope may come to life in your own practice of surgery if this blickling of homilies has succeeded in bringing these so-called simple tumours to your interest.

These ramblings owe much to the writings of Sir James Paget and his son Stephen Paget, and to my pleasant years of working with the surgical staff at the Western Infirmary of Glasgow.

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ELECTION TO THE COUNCIL—1st JULY, 1948

Sir Harry Platt was re-elected and Sir Archibald McIndoe and Mr. R. C. Bro were elected Members of the Council for the period of eight years.

1,588 Fellows voted : in addition 22 votes were found to be invalid.

The result of the Poll was as follows :—

Candidates	Votes	Plump
SIR HARRY PLATT	672	11
SIR ARCHIBALD HECTOR MCINDOE, C.B.E.	454	12
RUSSELL CLAUDE BROCK	418	16
Arthur Dickson Wright	416	20
Rodney Honor Maingot	353	2
Eric William Riches, M.C.	331	13
Angus Hedley Whyte, D.S.O., T.D.	266	11
Alan Cecil Perry	239	13
Harold William Rodgers	217	6
Hugh James McCurrich	206	29
Ronald Henry Ottywell Betham Robinson	205	8
Hubert Wallace Symons	178	12
Marriott Fawckner Nicholls, C.B.E.	149	10
Alexander Croydon Palmer, O.B.E.	132	5

DISEASES COMMON TO MAN AND OTHER ANIMALS

Lecture delivered at The Royal College of Surgeons of England

on

25th July, 1947

by

R. E. Rewell, M.D., M.R.C.P.

Pathologist to the Zoological Society of London

IN STUDYING HUMAN DISEASE by experimental means, a number of assumptions are made about the method. That the reaction of the animal employed and of the human organism under the same circumstances are not necessarily analogous has been the source of many notorious errors. Even what constitutes the same circumstances may often be far from clear. The root source of the difficulty would appear to be the necessary assumption in all biology of the essential unity of the processes with which the science deals and without which assumption it would degenerate into the enumeration of a huge mass of unconnected facts " incomprehensible " in every sense of the word. Actually, the unity of many of the fundamental processes of life is apparent and gives point to the old conception of " protoplasm " as its fundamental basis. The reactions involved in ærobic respiration are very similar in all organisms, while even the apparently complex differences between the fermentative powers of moulds may be resolved into how far any one of them may be able to go along a given path.

When Virchow introduced " cellular pathology " he simplified the science by showing that the fundamental unit, the cell, can respond to a noxious stimulus only by degeneration or proliferation, the final result depending on the degree of specialisation of the cell itself, the tissue of which it forms a part and of the organism to which it belongs. D'Arcy Thompson has emphasised how such differences may be imposed on the cell or tissue by extraneous forces and in comparative pathology apparently wide differences can be resolved in this way. Thus, for the biologist differences and similarities in the reactions of cells are often made more clear than by interference, while to the practical medical man much light can be shed upon the abnormal processes in man and a more critical approach to experimental work in animals developed, even if only by showing what changes may be expected to arise spontaneously. Even more " practical " is the determination of reservoirs of infection and of the suitabilities of species for particular experiments.

In discussing the huge field of comparative pathology, it will be realised that for economic reasons especially, no attempt has been made to solve

many of the well-known problems and that the study is largely limited by the incomplete knowledge now in existence of such subjects as zoology and comparative anatomy. However, by the application of simple funda- mentals much light can be thrown on some of these problems.

In this paper, considerations of space forbid the discussion of such large subjects as neoplasms and parasitology.

Non-specific Inflammations

Cohnheim's classical experiments on the ear of the rabbit were found to be applicable directly to the process of acute inflammation in man, and indeed, the same sequence of events happens in all mammals. In birds the picture is somewhat complicated by the relatively small number of granulocytes present in the blood which have a somewhat different structure from those of mammals. The same applies to reptiles. However, it is found that these cells behave in the same way in processes of inflam- mation and that the same histological picture is produced whatever the group of animals concerned. Repair by fibrous tissue is even more non- specific in its histology and the fibroblasts and fibrocytes of mammals, birds and reptiles are indistinguishable.

Abcesses, therefore, will have the same structure, wherever they occur, and so will all septic processes in comparable organs with comparable channels by which infection may spread. Septic cholangitis has the same appearances in birds, mammals and reptiles and pyameia will affect the same organs in all three groups, except that it is unlikely to involve the kidneys of reptiles as their blood supply differs from that of the others. Acute salpingitis is the same in all mammals, spreads by the same paths and produces the same immediate and remote effects.

The site of septic processes will, of course, be modified by the very presence or absence of structures in different animals. Thus only man, the anthropoid apes, the wombat and some of the douroucoulis have appendices which are homologous, that of man being the most highly developed, contrary to popular belief, while that of the rabbit and the cæca of birds are probably not homologous. Appendicitis is known as a cause of death from perforation and general peritonitis in the gibbon and chimpanzee. Acute bacterial endocarditis is not uncommon in birds, but it is confined to the left side of the heart as they have no right atrio-ventricular valve cusps, although I have seen one case with chronic mural vegetations on the right side.

Inflammatory processes will be modified by the structure of the tissue in which they occur. Thus all mammals have the same type of lung, the air-passages terminating in blind alveoli. However, in the lungs of birds, the air passes through these into a system of air-sacs, and there are no pleuræ. The reptiles have a simple sac, the walls of which are thrown into a number of folds. In snakes, these are quite low and much of the organ is without them, forming a simple air-sac distal to the absorbing surfaces. The inflammatory exudate of pneumonia is strictly comparable in all these

organs, but in mammals it becomes distributed in patches following the lobular pattern, as in the broncho-pneumonia of man. True lobar pneumonia is seldom seen spontaneously. In birds, the exudate runs quickly from one part of the lung to the other, so that wide areas become consolidated from the start. In reptiles it covers the surfaces and lies free in the cavity of the organ. In fact the inflamed lung of a snake shows an appearance very like the enteritis of other groups (Fig. 1). The appearance of enteritis is identical in detail in all three groups in fact, although in reptiles it does tend to show more sloughing of the mucosa and fibrosis of the submucosa.
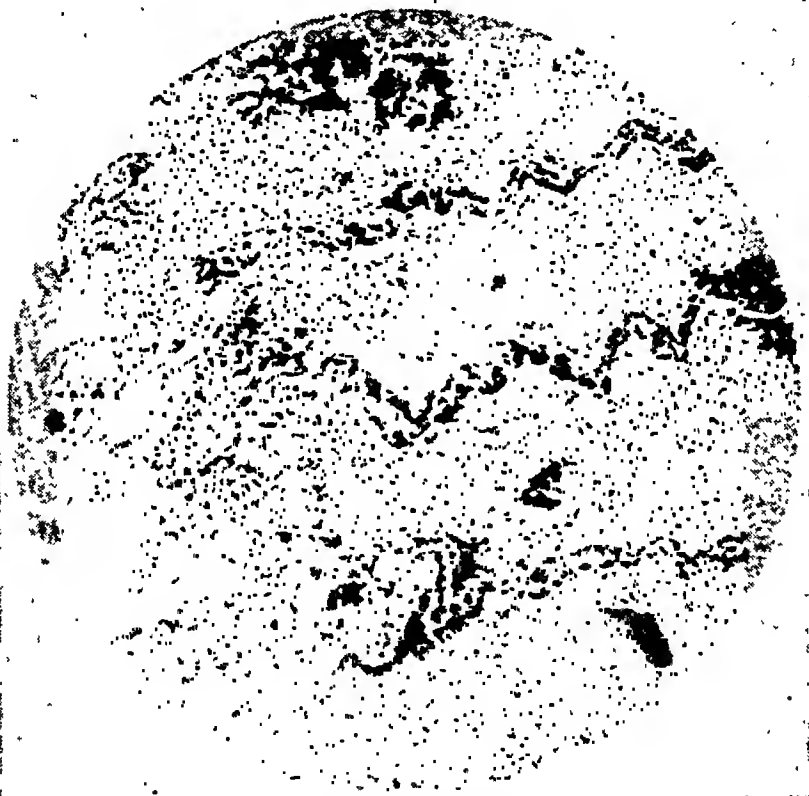
Fig. 1. Lung of a Hallowell's green mamba (X 50). The septa run from right to left of the figure to end freely. Inflammatory exudate lies between them and free in the lumen of the lung.

As a result of the presence of air-sacs in birds, infections of the lungs will spread readily into them, especially chronic ones such as mycosis. Direct spread from these, moreover, leads easily into the kidneys and gonads, in contrast to the pleural and transdiaphragmatic spread which is possible in mammals.

In contrast to the above, the structure of the long bones is the same in birds and mammals and an osteomyelitis will show the same tendency to arise in the metaphysis, to avoid the epiphysis and spread down the shaft, in these groups. Reptiles have no epiphyses.

Other Non-specific Processes

It is evident that different stimuli may produce the same result in some situations. Thus, the mammalian lung will respond by a " broncho-pneumonia " to a variety of organisms, although it may be that in such an instance all the organisms work through a similar chemical substance or by influencing the same reaction within the host cells. Another instructive example is that " subacute combined degeneration of the cord," identical in histological appearances with the condition in man, may occur in outbreaks in monkeys, when it is not associated with changes in the blood picture. Blood changes resembling human pernicious anæmia have been recorded in anteaters in captivity, and this in turn is not associated with nerve changes.

The processes of ulceration of mucous membranes resemble each other closely. Duodenal ulcers may be produced experimentally in dogs, but they occur spontaneously in different species of canidæ running as free as is possible for accurate observation, where death from perforation or hæmorrhage may occur. Gastric ulcers are found in many mammals, including marsupials. Fig 2 shows such a one from a wallaby, the glandular part of whose stomach is limited to a small area near the opening of the œsophagus. This resembles the condition in man to such details as the sudden break in the muscularis mucosæ at the edge of the ulcer and the obliterative endarteritis in its base. A similar picture is seen even in the gizzards of birds.

Fig. 2. Edge of a gastric ulcer in a Bennett's wallaby (X 50).

Specific Inflammations

True syphilis is not seen spontaneously, except in man, but mycotic and tuberculous lesions are common. Mycosis is especially common in water birds and probably is endemic in the wild. It affects the lungs and air-sacs, especially the left anterior thoracic air-sac, a fact which recalls the susceptibility of the right upper lobe of the lungs of man to abscess formation. Mycosis is rare in mammals, and here, once again, it affects the air-passages and pleuræ.

Tuberculous processes show certain differences between groups of animals. Even among mammals these are evident. Thus in monkeys, a distinct type of lesion occurs. Grossly it appears rather like an acute abscess, although the centre is more caseous. Microscopically a central area of necrosis occurs with a scanty exudate in which polymorphs may abound. Endotheliod cells are few and giant cells absent. Acid-fast bacilli are seen in the edges and *Mycobacterium tuberculosis* can be cultured. This is usually of the human strain. In other situations in mammals, tubercles resemble the human one, but they are always of the acute or primary type. The secondary type of lesion with much fibrosis and following a primary infection is never seen except in man. Even in the great apes, chronic cavities in the lung are very rare. It would appear that no racial immunity has developed, even in cattle and it is noteworthy that the epidemiology of tuberculosis in most mammals, including apes, resembles that of primitive peoples who have been brought into contact with civilised communities, in that its incidence increases with the duration of captivity.

In birds, tuberculous lesions resemble those of mammals grossly, but microscopically the exudate is less easy to distinguish from that of a pyogenic process. Giant cells are absent and it may be difficult to distinguish the lesions from a non-specific one, except by the presence of acid-fast bacilli. These may be found in very large numbers forming solid masses. Birds possess lymph channels, but few have any lymph nodes and spread of the infection is by the veins, in the lumena of which the organism may be seen in heavy infections. The usual route of infection is alimentary. Thus the liver and spleen are involved most often, then the lungs and air-sacs, from which spread to the gonads or kidneys may take place. I have seen one case of involvement of the brain. This appears to be unique. Birds are susceptible only to the avian bacillus, except parrots. Warts swarming with human bacilli may occur on the feet of these birds and spread from man to parrot and back to man. This has been recorded.

Tuberculosis is probably unknown in wild birds and again its incidence increases with the duration of captivity. This is in marked contrast to mycosis as may be seen in the table.

Tuberculosis of reptiles is rare. It occurs most often in the lungs of pythons and crocodiles. In reptiles, all processes of inflammation are

chronic and the lesions are not very specific either grossly or microscopically. The reptilian strain of organism is involved. The bacilli are larger than the avian ones and are more like the human morphologically. Their demonstration is necessary for the diagnosis.

TABLE

	Mycosis	Tuberculosis
Birds under six months in the gardens ..	21	4
Birds over six months in the gardens ..	7	12

Table showing the numbers of deaths attributed to mycosis and tuberculosis among birds in the Zoological Gardens in Regent's Park during 1946.

Some Problems of Comparative Immunity

Among birds and mammals, *Staphylococci* and *Streptococci* appear to be responsible for abcesses and cellulitis and I have isolated a coagulase-positive *Staph. aureus* from purulent ophthalmia in a baby pig. In reptiles, however, organisms of the *Proteus* group are more common in skin lesions.

The intestinal floras of most animals are very similar, but inflammations of the gut are caused by different organisms in different groups and often no obvious pathogen can be isolated from an inflamed gut. There is a very severe type of enteritis which occurs in snakes of many types, probably occurs in the wild and results in complete sloughing of the mucosa and much fibrosis. It occurs in definite outbreaks, but no obvious pathogen or parasite has ever been isolated. This leads to the obvious point that in unusual animals the investigator is never sure that an organism harmless to man or common animals is not pathogenic to them. For economic reasons, he is seldom able to satisfy Koch's postulates, as few animals are sufficiently valuable to warrant his spending the time, or else they are too valuable to be used for experiment.

Some organisms cause different lesions in different animals. Thus a variety of *Salmonellæ* have been isolated from mammals, birds and reptiles, not always from the gut. Thus *S. typhi murium* may cause enteritis in man, a condition resembling human cholera in the sheep, septicæmia in rodents, pyæmia in monkeys and a condition like typhoid fever in penguins. Human dysentery organisms may occur in apes and monkeys, e.g., *Shigella flexneri* of several types.

On the other hand, different organisms may cause very similar lesions in different groups. Thus the viruses of canine distemper and human influenza can produce an identical picture in the lungs of canidæ and of man respectively, but only the ferret is known to be susceptible to both. Such susceptibilities may or may not follow the accepted zoological classifications. Thus canine distemper once more affects all the canidæ, but is not known to occur in the closely related racoons or badgers, while the less closely related ferret, one of the mustelidæ, is susceptible. Feline distemper and feline infectious enteritis affect all the felidæ except large lions and tigers. This is not entirely a matter of size since large, adult

leopards may have a most fulminating form of acute enteritis and die within two hours of the first signs, i.e., tearing at their own abdomens, presumably in agony, with rapid loss of consciousness.

On the other hand, it is well known that dogs suffer from an enteritis due to hæmolytic strains of *Escherichia coli* which are not pathogenic to man and I have some evidence that badgers may be affected by such strains. The influence of the body temperature on the action of the toxin of *Clostridium tetani* is classic.

The subject is obviously too large to be discussed at any length.

Degenerative Changes

Such processes as cloudy swelling, or fatty degeneration, and even the finer cytological changes of cell-degeneration, are fundamentally analogous throughout the animal kingdom. There are one or two curious surprises, however. Thus the liver of an hibernating animal, such as a dormouse killed by accident, shows what in other types of animal, or even in the same animal during the summer, would be interpreted as an extreme degree of fatty degeneration, and the fact that this is reversible is surprising.

The changes of senility in cells, such as accumulation of pigment round the nuclei of muscle cells, are seen in all groups, but the gross changes are seldom as obvious as in man, a fact which is surprising in view of the great age which some animals attain in captivity. In birds and mammals, the muscles become fibrous and the fat is lost, but in reptiles, even this is not seen. In mammals, the coat may lose its colour, but very old birds retain their full display plumage and loss of the colour of feathers in captivity, e.g., in the flamingo or cock-of-the-rock, can be traced to dietary deficiencies. Naturally, dead structures such as beaks or teeth, except the incisors of rodents, will show mechanical wear.

Of endocrine changes, some animals, e.g., the elephant, retain their reproductive powers into extreme old age in the female and only the higher apes have anything like a menopause. Cystic disease of the thyroid is common and so is prostatic hypertrophy. However, in many animals, e.g., marsupials, the so-called prostate is not really the homologue of that organ in man, while in others the gland does not surround the urethra so that urinary obstruction is not produced. Most elderly canidæ suffer from fibrosis of the prostate which does not show the true hypertrophy of the mucosa seen in man, although this does occur in these animals when stimulated with œstrogens.

Arterial degenerations are most interesting, as it is remarkable how slight these are, even in the oldest members of most species. The same degree of arterial degeneration seen in the body of any human dying in the 50's is never found in other animals. I have seen Monkeberg's sclerosis once, in a Mitchell's wombat aged more than 20 years. In birds, true atheroma with subintimal collections of cholesterol is rare. Degeneration

is rarer still in the arteries of reptiles, though it may be seen in the crocodiles or the larger lizards.

As a result of this, few animals, apart from man and the cart horse, die of vascular catastrophes, although I have been informed privately of coronary occlusion in a chimpanzee. Birds sometimes have cerebral hæmorrhages, but these are not associated with arterial degenerations. Fig. 3 shows the kidney of an extremely aged pine marten. Hyaline glomeruli are very few.
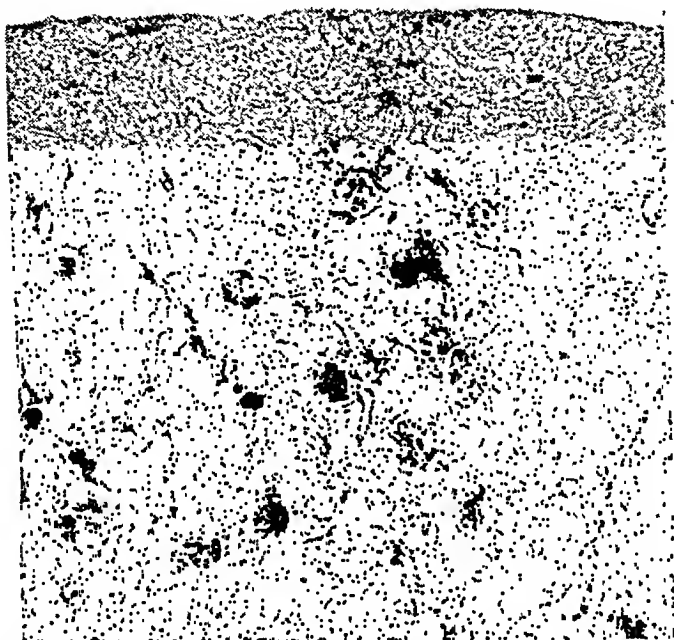
Fig. 3. Kidney of a very old pine marten, aged at least 22 years (X 50). Very few hyaline glomeruli are present.

Spontaneous hypertension does not appear to occur in animals other than man, although there is no reason why unilateral kidney lesions should not produce it in mammals. The details of the blood supply of the kidneys in birds and reptiles differ from that of mammals, although recent studies have not been undertaken.

Such degenerative processes as amyloid disease seem to have the same characteristics in birds and mammals, although in the former group it appears to arise spontaneously in many cases, with no preceding chronic inflammation. The microscopical picture is the same, however.

The Distribution of Certain Conditions

Since man has been studied more than any other animal, it is to be expected that many of the conditions found in him should not have been recorded in other animals. However, certain conditions appear to be peculiar to him. Thus the changes of acute nephritis or rheumatic fever

do not appear to have been observed spontaneously in other species and attempts to reproduce them in experimental animals have met with but partial success. Only recently have lesions comparable to Læennec's cirrhosis of the liver been reproduced experimentally, but it is of interest to note that an exactly comparable condition arises in most Arabian camels in captivity in temperate climates, although the Bactrian camel does not show it. The same condition is seen in certain felidæ, e.g., cheetahs. It is a pity that these animals are too bulky, long-lived and expensive for experimental work.

Other distributions of an unexpected character have been mentioned above. It may be added that bronchiectasis occurs commonly in the larger felidæ also.

Conclusions

From the above very brief survey it is seen that the principles which underly the pathology of man can be used readily to elucidate that of other animals and that knowledge gained from them may be of use to those engaged in attacking the problems of disease in man also.

Photographs by permission of Messrs. Ilford, Ltd.

THE WORSHIPFUL COMPANY OF BARBERS

The Council of the College dined with the Court of the Worshipful Company of Barbers on 1st June. This was the third successive year in which the Barbers and Surgeons have thus commemorated their former alliance, and on this occasion the hosts were the Barbers' Company and the dinner was held in Tallow Chandlers' Hall, which the Barbers have used since the destruction of their own hall by enemy action in 1940.]

The Master (Mr. J. R. Hovenden) proposed the health of the Council, and the President in his reply recalled how the two bodies when united had fulfilled the functions not only of the present Company and College, but the General Medical Council and British Medical Association as well, not to mention other medical corporations.

Sir Cecil Wakeley gave the toast of the Barbers' Company, and Mr. S. M. Young, jnr., described some of the Company's treasures, mentioning in particular the Grace Cup presented by Henry VIII to the Barber-Surgeons on their union in 1540, an event immortalised by the famous Holbein cartoon.

Mr. A. Charles Knight, responding to the toast of the Clerk, spoke in appreciation of the hospitality of the College during the war when the Barbers' Company were unhoused by enemy action.

Lighter entertainment was provided by Miss Olwen Davis, who delighted her audience by her charming personality and pleasing soprano voice.

Baron Webb-Johnson of Stoke-on-Trent, President of the Royal
College of Surgeons of England, who was elevated to the
Peerage in the Birthday Honours List.

7. THE ERASMUS WILSON TANKARD AND GOBLETS

AMONG THE PLATE in the possession of the College is a large tankard or flagon with a pair of goblets which belonged to Sir William James Erasmus Wilson, F.R.S., President of the College in 1881, and one of its greatest benefactors.

The Honorary Gold Medal of the College is mounted in the lid of the tankard and was decreed by the Council to Sir Erasmus Wilson in 1884. This was only the seventh award of the Medal since its institution in 1802. The tankard and goblets were presented to Edward Trimmer, Secretary of the College in 1886, in remembrance of Sir Erasmus by their mutual friend, Charles Alfred Swinburne. They were purchased by the College from Mrs. Trimmer in 1905.

The inscription on the tankard reads as follows :—" Presented to Erasmus Wilson, Esq., by the Family of The Late Right Honourable Lieut.-General Sir George Arthur, Bart., K.C.H. (*vide infra*), D.C.L., in gratitude for his kind attention and eminent skill during a long illness, September, 1854."

The Erasmus Wilson Tankard and Goblets.

Erasmus Wilson was one of the original 300 Fellows of the College. He lectured on Anatomy and Physiology and Dermatology at The Middlesex Hospital, after being Assistant in Anatomy to Jones Quain at University College. He was one of the first and best of the English specialists in diseases of the skin. He was fond of foreign travel and was particularly interested in the study of Egyptian Antiquities. In 1877 he paid the cost (about £10,000) of the transport of " Cleopatra's Needle " to London. Hence the soubriquet " The Obelisk " which was used by " Spy " (Sir Leslie Ward) in 1880 in his cartoon of Erasmus Wilson in the magazine " Vanity Fair."

" The Obelisk "

Erasmus Wilson was a skilful investor and became a rich man. He devoted his wealth to various charitable objects. He built the Headmaster's House at Epsom College, to which he was a generous subscriber. He also built a new Wing and Chapel at the Royal Sea-Bathing Hospital at Margate at a cost of nearly £30,000. He founded the Erasmus Wilson Lectures at the College and the Professorship of Pathology at Aberdeen University, the latter in memory of his father. The bulk of his fortune, amounting to over £200,000, he bequeathed to the Royal College of Surgeons.

Other mementoes at the College of this great benefactor are a bust by Sir Thomas Brock, R.A., in the Library, a copy of the portrait by John L. Reilly, the original of which is in the Medical Society of London (of which Erasmus Wilson was President in 1878), and the Silver Medal of the Royal Humane Society awarded to him for saving the life of Olivia Green, who attempted to commit suicide by jumping into the Regent's Park Canal on April 22, 1857.

K.C.H.

Sir George Arthur was a distinguished Colonial and Indian Administrator, and the letters, K.C.H., after his name indicate that he was a Knight Companion of the Guelphic Order of Hanover, receiving this distinction in 1837, the last year of its award in England. The Guelphic Order of Hanover was founded in 1815 by George IV when Prince Regent. There were three classes of Knights of the Order: Knights Grand Cross (G.C.H.), Knights Companions (K.C.H.), and Knights (K.H.), and medals were also provided for N.C.O.s and private soldiers. The award was restricted to " persons who have distinguished themselves in a particular manner." The Order was discontinued as a British Award after the death of William IV when the British Sovereign ceased to be Monarch of Hanover. Among the recipients of this distinction was Sir Charles Bell (of Bell's Palsy and the Nerve of Bell), who was awarded the K.H. in 1831.

. In one of Bell's letters is the following description of his experience at the Levée when he was invested with the Order.

" The intended batch consisted of Herschel, Babbage, Leslie, Ivory and Brewster, the object being to show respect from Government for men of science, and it was determined that the Guelphic Order should become the mark of distinction for scientific men. We shall soon see what comes of this ! How many are there who think themselves deserving of this honour ! However, in the meantime, the batch makes it respectable."

" I persuaded Herschel that on this occasion he represented the higher sciences, and that, therefore, he must precede me into the presence chamber, but in approaching the lord in waiting he lost heart, and suddenly countermarched, so that I found myself in front. My niece's dancing-master having acted the king the night before, I had no difficulty."

<div align="right">W-J.</div>

DIARY FOR JULY (15th—30th)

Thur. 15   5.00   Prof. T. P. McMurray—Derangements of the Knee Joint.
          5.00   Dr. J. Short—Development of the Jaws.
          6.15   Dr. R. L. Waterfield—Blood—Physiological Aspect (2).
Fri.   16   D.O.M.S. Examination (Part II) begins.
          5.00   Prof. A. F. Jackson—Charles Tomes Lecture—Growth and
                Development from the Clinical Aspect of Orthodontics.*
Mon. 19   5.00   Prof. S. L. Baker—General Pathology of Bone (1).
          6.15   Dr. C. H. Tonge—Surgical Anatomy in Relation to Regional
                Anæsthesia.
Tues. 20   5.00   Prof. S. L. Baker—General Pathology of Bone (2).
          6.15   Dr. C. H. Tonge—Anatomy of the Oral Cavity.
Wed. 21   5.00   Mr. E. B. Manley—The Histology of the Dental Tissues (1).
          6.15   Prof. G. P. Wright—The Spread of Infection in Tissues.
Thur. 22   D.T.M. & H. Examination begins.
          5.00   Prof. R. J. Brocklehurst—Taste.
          5.00   Prof. John Beattie—The Changes in Volume and Distribution
                of Body Water under conditions of Stress.*
          6.15   Mr. E. B. Manley—The Histology of the Dental Tissues (2).
Fri.   23   5.00   Mr. E. B. Manley—The Histology of the Dental Tissues (3).
          6.15   Mr. R. T. Payne—Acute Infection of the Salivary Glands.
Mon. 26   5.00   Prof. H. A. Harris—Clinical Anatomy of Thorax.
          6.15   Mr. A. Bulleid—Bacteriology of the Mouth.
Tues. 27   5.00   Prof. D. T. Harris—The Autonomic Nervous System.
          6.15   Dr. A. C. Counsell—Ætiology of Cysts of the Mouth.
Wed. 28   5.00   Dr. M. W. Carr—Charles Tomes Lecture—Acute Infections
                of the Face and Neck of Dental Origin.*
Thur. 29   5.00   Prof. Shafik Shalaby—Hunterian Lecture—Amœbic Liver
                Abscess.*
          5.00   Dr. W. A. M. Smart—Circulation.
          6.15   Prof. G. P. Wright—Repair of Connective Tissues.
Fri.   30   5.00   Dr. C. Reid—Respiration and Anoxæmia.
          6.15   Prof. R. Hare—The Source and Transmission of Wound
                Infection.

* Not part of courses.

The College will be closed during August.

MONTHLY DINNERS

Monthly dinners held in the College will be resumed in October. The following are entitled to attend with their guests. All Diplomates and students of the College, and Members of the Associations linked to the College through the Joint Secretariat. It is not necessarily intended that guests should be members of the medical profession.

The dinners will be at 7 p.m. on the following Wednesdays :—13th October, 10th November, and 8th December, 1948. There is an inclusive charge of £1 5s. 0d. (including drinks), which must be sent with the application to the Assistant Secretary at least a week before the date of the dinner. The dress is Lounge Suit or Uniform.

OPERATIONS PERFORMED AND VASCULAR ANOMALIES ENCOUNTERED IN THE TREATMENT OF CONGENITAL PULMONIC STENOSIS*

by

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AT THE PRESENT TIME there are three types of congenital heart disease that are amenable to surgical treatment. The first type to be treated successfully was the patent ductus arteriosus. This abnormality consists of the persistence into later life of the ductus arteriosus as a communication between the pulmonary artery and the aorta. There is no cyanosis, but there may be retarded physical growth, cardiac failure, or the development of endarteritis. The proper treatment, obviously, is interruption of this unnecessary and detrimental channel. Coarctation of the aorta is the second condition, which responds favourably to surgical therapy. Associated with the constriction in the aortic isthmus, these patients are prone to the development of hypertension, aneurysm and rupture of the aorta, and cerebrovascular accidents. In the majority of these patients the coarcted area of the aorta can be surgically excised and an end-to-end anastomosis performed with excellent results. The third group is made up of patients who are constantly cyanotic to a greater or lesser degree as a result of inadequate pulmonary blood flow and shunting of mixed venous blood to the arterial circulation. It is this condition, the commonest form of which is the tetralogy of Fallot, that forms the subject of this report.

Fig. 1A demonstrates the four anatomical features of the tetralogy of Fallot. These are: (1) Pulmonic stenosis or atresia, usually in the infundibular region of the pulmonary conus and occasionally involving the pulmonary valves, (2) a high interventricular septal defect situated in the membranous part of the septum beneath the origin of the great vessels, (3) a dextroposed aorta overriding the septal defect, and (4) hypertrophy of the right ventricle. As a result of the shunting of mixed venous blood through the overriding aorta, patients with this condition constantly have some unsaturation of the arterial blood, which increases when bodily demands are greater, as upon exertion. An inadequate blood flow to the lungs accompanies the pulmonic stenosis, and only a fraction of the venous blood entering the right auricle courses through the lungs for oxygenation. The intolerance to exercise and

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TETRALOGY OF FALLOT
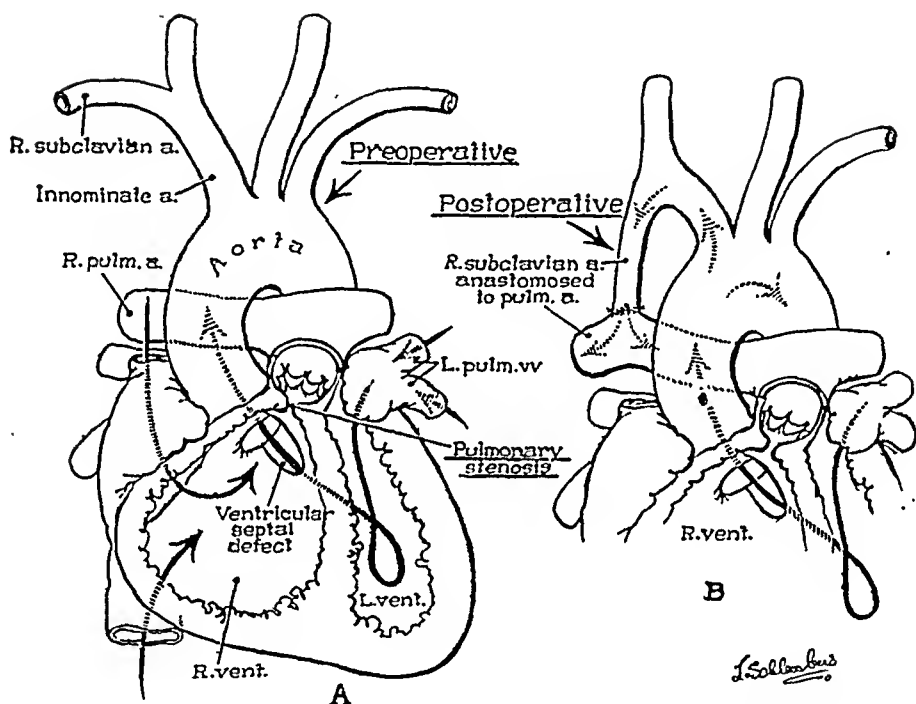
Fig. 1A. Diagram showing the tetralogy of Fallot. This demonstrates the pulmonic stenosis in the conus region, the interventricular septal defect, the aorta which overrides the defect and receives some venous blood, and the right venticular hypertrophy.

Fig. 1B. Diagram showing the tetralogy of Fallot after operation. The proximal end of the right subclavian artery has been anastomosed to the side of the right pulmonary artery, thus shunting incompletely oxygenated blood from the aorta into the pulmonary arteries.

the cyanosis are present because of these two components of the tetralogy—namely, the overriding aorta and pulmonic stenosis. It is only because of the coexistence of these two factors that successful surgical therapy can be carried out. It is apparent that if some of the improperly oxygenated blood from the aorta can be shunted through the pulmonary arteries by an artificially created ductus arteriosus, it will acquire more oxygen without overloading the diminished pulmonary circulation. Fig. 1B shows the arrangement of the circulation following the completion of an end-to-side anastomosis. In contrast to this condition is the one known as pure pulmonic stenosis, a rare abnormality in which there is no septal defect or overriding aorta. All of the blood returning to the left side of the heart and subsequently being ejected through the aorta is properly oxygenated and hence, although the volume of pulmonary blood flow may be greatly reduced, a great deal cannot be gained by shunting aortic blood through the lungs again.

There are, however, many congenital cardiac conditions which are amenable to the creation of an artificial ductus arteriosus. These include the tetralogy of Fallot with pulmonic stenosis or atresia, a single ventricle with pulmonic stenosis, tricuspid and pulmonary atresia, pulmonic stenosis with an interauricular septal defect, transposition of the great vessels with pulmonic stenosis and a large interventricular septal defect, and many variations of these abnormalities. Perhaps patients with an interventricular septal defect and an overriding aorta but without pulmonic stenosis, as in the Eisenmenger's complex, may be benefited, although this point has not been determined. Certainly the primary indication for operation is an inadequate blood flow to the lungs with an interventricular septal defect and an overriding aorta.

The criteria for the diagnosis of pulmonic stenosis or atresia have been described in detail by Dr. Taussig [2] and others. Cyanosis, dyspnea, poor tolerance for exercise, squatting, a systolic murmur in the pulmonary area, low arterial oxygen saturation, polycythemia, a concavity in the region of the pulmonary artery on X-ray examination, a clear pulmonary window, diminished hilar shadows, and absent pulsations at the lung hila on fluoroscopic examination, are the more important positive points in diagnosis. In general, the most important information is obtained by roentgenography and fluoroscopy. Dr. Richard Bing and his co-workers [3] have described a valuable laboratory test which consists of measuring the ratio of oxygen consumption to volume of ventilation before and after exercise. In normal persons this ratio increases, in contrast to those with an inadequate pulmonary blood flow in whom the ratio falls.

Technique of Operation

The possibilities of operative treatment of the tetralogy of Fallot and allied conditions include a direct attack upon the pulmonic stenosis and

the performance of a shunting operation by which the stenotic area is by-passed. In contrast to acquired heart disease, congenital pulmonic stenosis is usually below the valves and involves the pulmonary conus. An incision into this region would not only be dangerous, but the effects would probably be only temporary as further scarring occurred. The performance of a shunt operation, on the contrary, is facilitated by the proximity of the aortic arch and its branches to the pulmonary arteries. Because of the large pressure gradient between these vessels, we may expect an anastomosis to remain patent and to carry a large volume of blood into the pulmonary circulation.

There are a number of procedures by which the systemic and pulmonary circulations may be connected in the performance of the shunt operation. The subclavian branch of the innominate artery may be anastomosed to the end or to the side of the pulmonary artery to the lung on that side of the body. The carotid or the innominate artery may be similarly anastomosed. The subclavian artery which arises directly from the aorta may be anastomosed to the end or the side of one of the pulmonary arteries, or lastly, the aorta may be anastomosed directly to one of the major branches of the pulmonary artery in a side-to-side manner. The type of operation must be selected to fit the individual case. We prefer to use the subclavian artery, which arises from the innominate and to make an end-to-side anastomosis, because the subclavian artery arising from the innominate makes a better angle after completion of the anastomosis than that which arises directly from the aorta. An end-to-side procedure is preferred because it allows the shunted blood to go to both lungs with less danger of an excessive burden on either.

In order to utilize the subclavian artery one must determine pre-operatively the position of the aortic arch, since in a large number of cases in this group of patients the aorta arches over the hilum of the right lung instead of the left. The radiological method described by Bedford and Parkinson[4] is used to ascertain the side. The innominate artery remains the first vessel to arise from the aorta, regardless of whether the arch is to the right or the left. Hence, if one wishes to use the subclavian artery arising from the innominate, it can best be approached from the right with a left aortic arch or from the left with a right aortic arch.

The various steps in the operation which we usually perform may be seen in Figs. 2 to 7. The patient is placed on his back with the operative side slightly elevated and on a table which may later be tilted away from the operator. The incision is made from the edge of the sternum to the apex of the axilla. In females it is thought advisable to circle beneath the breast in making the skin incision. In the majority of the patients the chest was entered through the third intercostal space. It is now our policy to utilize the second interspace in all patients except infants, since this allows a more complete expansion of the lung on the operated side

as well as a better exposure of the apex of the chest. The azygos vein is divided, a step which permits freer dissection in the hilum of the lung and exposure of the pulmonary artery. This vessel is mobilized as completely as possible. Dissection is then carried beneath the superior vena cava, and the innominate artery is identified as it arises from the aorta. In following this vessel distally to its branches one may be guided by the vagus and recurrent nerves in locating the subclavian artery. After these structures are identified it is possible to divide the mediastinal tissue with greater freedom. It is important to free the subclavian, carotid and innominate arteries in order to gain as much mobility as possible for the vessel to be anastomosed. A rubber-shod clamp is applied to the subclavian artery proximally. A ligature is placed distally where the artery branches, and it is divided just proximal to the ligature. The end of the subclavian artery is freed of adventitia to avoid its being caught in the suture and causing constriction of the anastomosis. At this point the lung is inflated and the patient is allowed to rest.

The pulmonary artery is occluded proximally with a special clamp and distally with rubber-shod clamps and traction upon untied silk ligatures which have been placed around the branches. A transverse opening is made in the superior surface of the pulmonary artery a trifle larger than the end of the subclavian. Again the adventitia is removed to avoid its inclusion in the suture line. An anastomosis is performed between the end of the subclavian and the side of the pulmonary artery with 5-0 silk on an atraumatic needle. The suture is a continuous one, everting and approximating the intima. The posterior row is placed before it is pulled taut, and additional stay sutures are placed at either end to anchor the continuous suture. The anterior row is completed by using a similar stitch. This part of the anastomosis is usually easier than placing the posterior row. There is often a slight ooze from the suture line on removal of the occluding devices, but this usually stops with brief pressure. If there is a considerable leak it can be stopped with an additional suture.
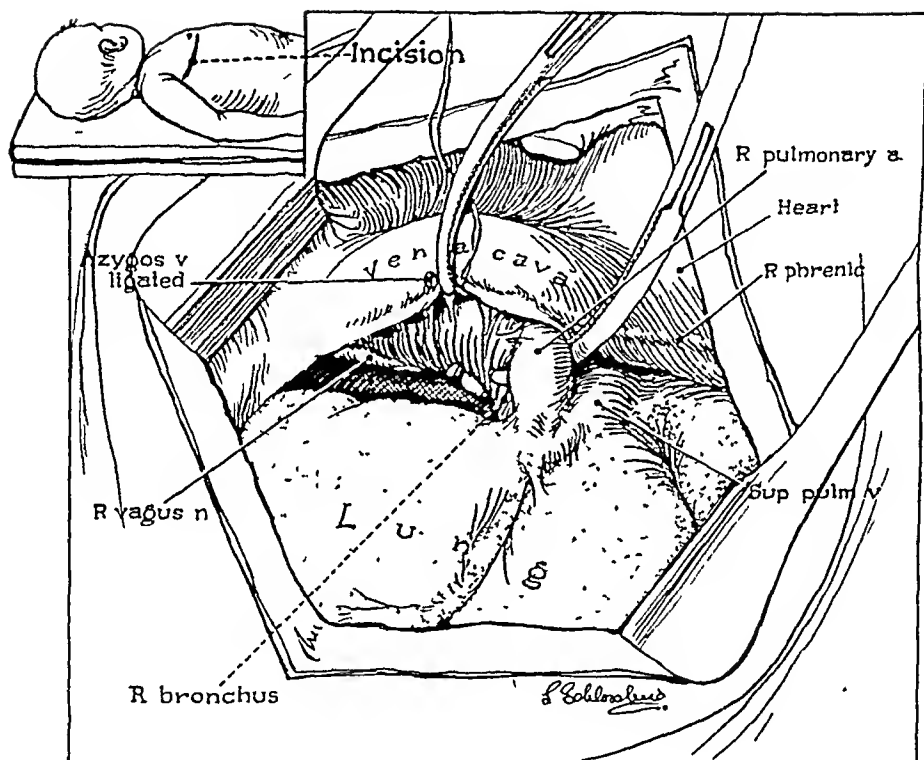
Fig. 2. Inset shows the position of the patient for a right thoracotomy. The azygos vein has been divided and the superior vena cava is retracted with it. The right pulmonary artery has been freed and a clamp placed under it. The artery should be thoroughly mobilized and the branches freed laterally.
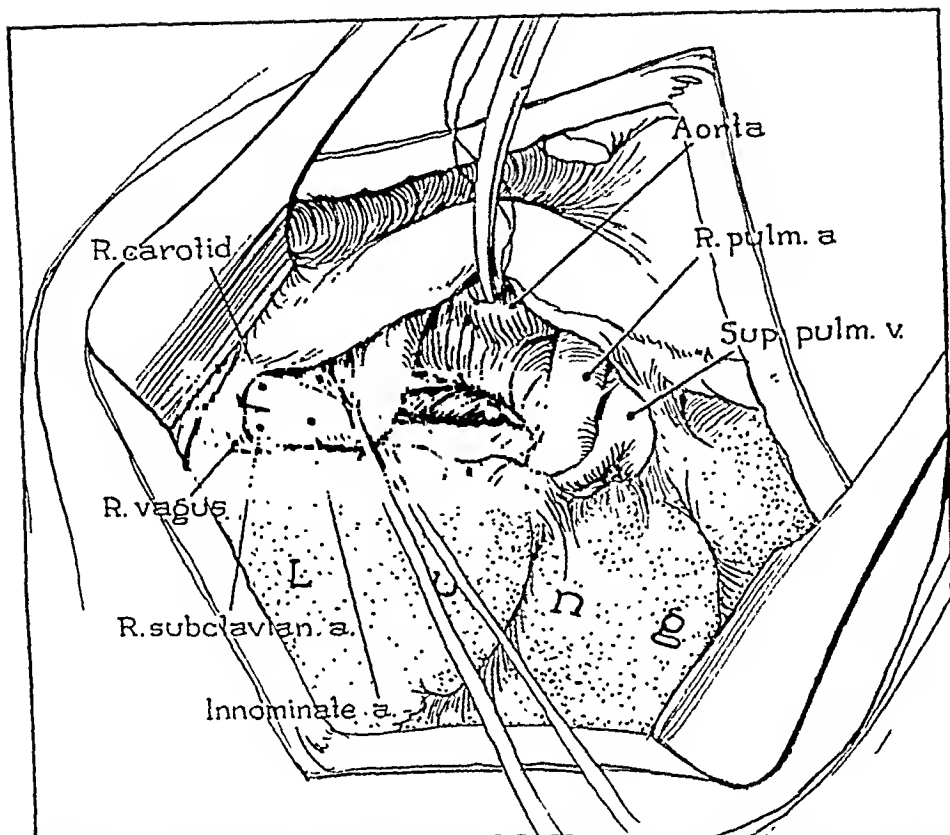
Fig. 3. By dissection under the superior vena cava the innominate artery has been identified and freed proximally to the aorta and distally to the branches. The vagus nerve is seen.
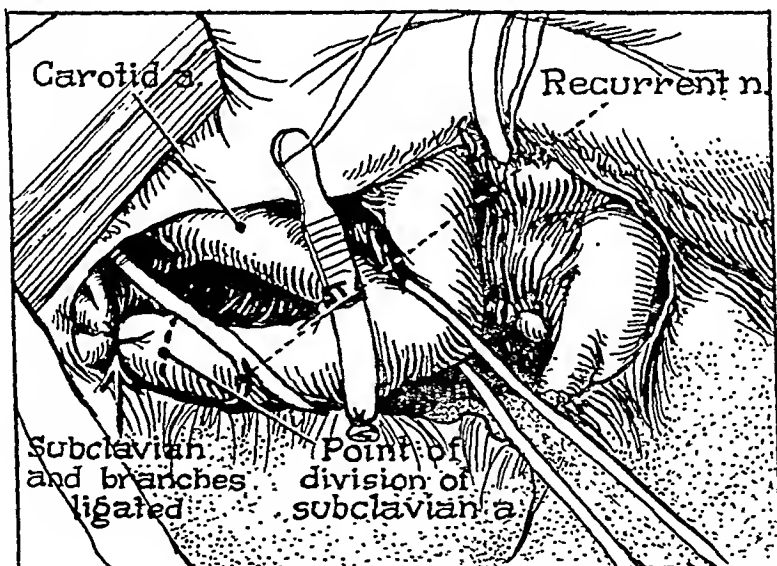
Fig. 4. The right subclavian artery has been freed and ligatures have been tied around the branches. A rubber-shod clamp has been placed on the artery near its origin and tied in place to prevent slipping. The artery will be divided just proximal to the ligature.
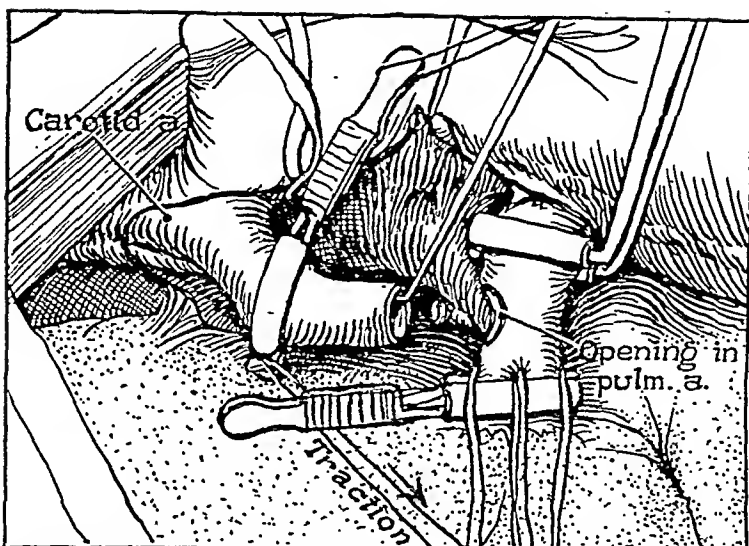
Fig. 5. The pulmonary artery has been occluded proximally with a special instrument and distally by a rubber-shod clamp and traction upon untied ligatures. A transverse opening has been made in the superior aspect of the pulmonary artery. The vessels can be approximated by downward traction on the rubber-shod clamp on the subclavian and upward pressure on the special instrument on the pulmonary artery.
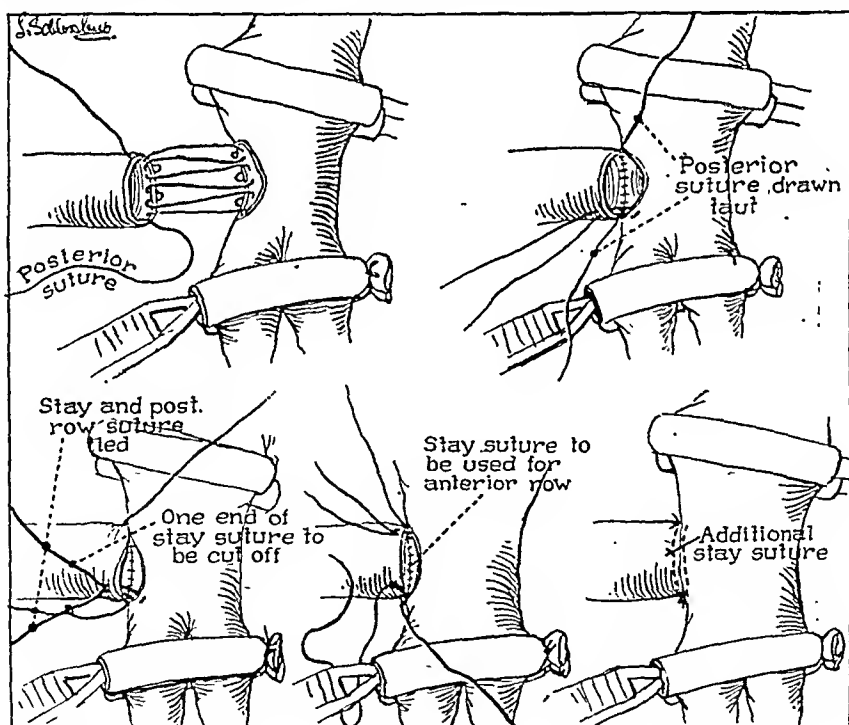
Fig. 6. Detailed sketch of the anastomosis. 5-0 silk on an atraumatic needle is used. The suture is continuous, everts the wall of the vessel, and approximates the intima. The posterior row is placed before it is drawn taut. Actually very little silk shows after the suture is drawn taut. The interrupted sutures are placed for anchorage and to prevent a purse-string effect.
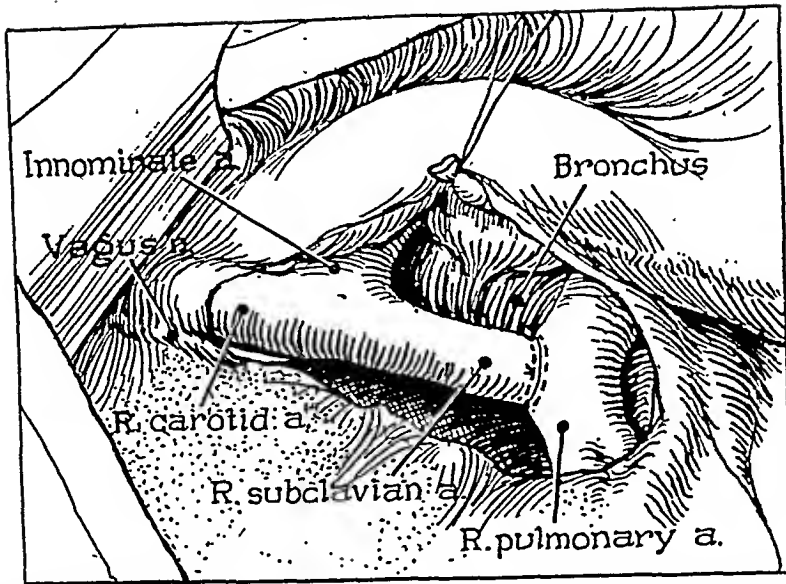
Fig. 7. The end-to-side anastomosis has been completed. Note the angle which the subclavian artery makes with its parent vessel; the innominate. Compare this with Figure 8.
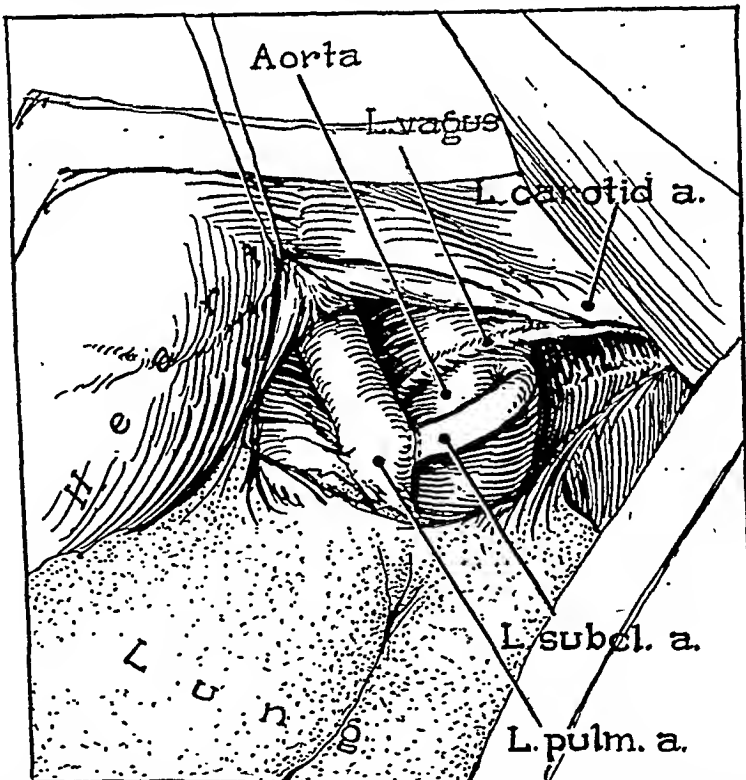
Fig. 8. An end-to-side anastomosis made by using the subclavian artery which arises from the aorta. Note the angulation at the origin of the artery. In some cases there may be enough tension actually to flatten the subclavian. This may be lessened by suturing the pleura over the lung to the mediastinal pleura and by inflating the lung.

Fig. 7 shows the angle which the subclavian artery makes with its parent vessel after the anastomosis is completed. In contrast to this Fig. 8 demonstrates how the subclavian arising from the aorta may be flattened against the wall of the aorta if there is any tension following the completion of the anastomosis. It is for this reason that we prefer, if possible, to use the subclavian arising from the innominate artery. The contralateral operation is usually easier to carry out, however, and there are many surgeons (5, 6, 7) who are performing the procedure with excellent results.

Although early in the series we frequently made use of other systemic vessels than the subclavian, we have recently been doing so only rarely. By adequately freeing the systemic arteries and especially by dividing the adventitia along the branch of the pulmonary artery to the lower lobe, one can almost invariably secure enough length to approximate the two vessels. If the arteries can be approximated for the completion of the anastomosis, one need have no fear of there being too much tension when doing the preferred operation, for further approximation is attained by the removal of the occluding devices and the inflation of the lung. This is not the case when one uses the subclavian arising directly from the aorta since very slight tension will cause it to buckle at its point of origin. The size of the not infrequently small subclavian artery is rarely a contra-indication to the use of this vessel in the anastomosis. It often looks smaller when stretched and angulated by the vagus and recurrent nerves than it does after it is divided, and because of the pressure gradient a small systemic vessel will carry a large quantity of blood.

Although we prefer to use the subclavian in an end-to-side anastomosis, an operator must be prepared to perform other procedures in individual cases. The use of the carotid or the innominate artery entails a greater risk to the patient with the cutting off of this portion of the blood supply to the brain. This may be unavoidable in some cases in which the distance between the systemic and pulmonary arteries is great and the vessels are short. Rather than use one of these vessels, we much prefer to perform an end-to-end anastomosis, dividing the pulmonary artery far proximally in order to get added length. An end-to-end anastomosis should certainly be performed in patients in whom the pulmonary artery is extremely small, unless there is too great disparity in size between the two vessels. The decision should be made before attempting an end-to-side procedure, since valuable length may be lost by attempting an end-to-side anastomosis. The appearance of a completed end-to-end anastomosis is seen in Fig. 9. One reason for our hesitancy in doing end-to-end anastomoses has been the fear that we would not be able to do a second operation on the other side should this be necessary. Recently, however, such a procedure was carried out on a child who satisfactorily tolerated occlusion of the pulmonary artery and the remainder of the operative procedure with a dramatic result.
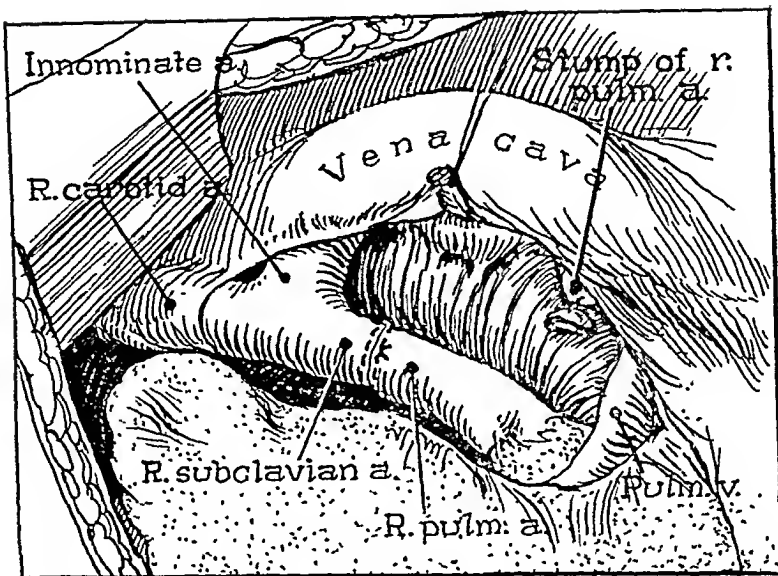
Fig. 9. Anastomosis between the end of the right subclavian and the end of the pulmonary artery because of a short subclavian. A modified Carrel technique is used, which consists of placing three guy sutures around the circumference of the arteries and suturing between them with an everting stitch.
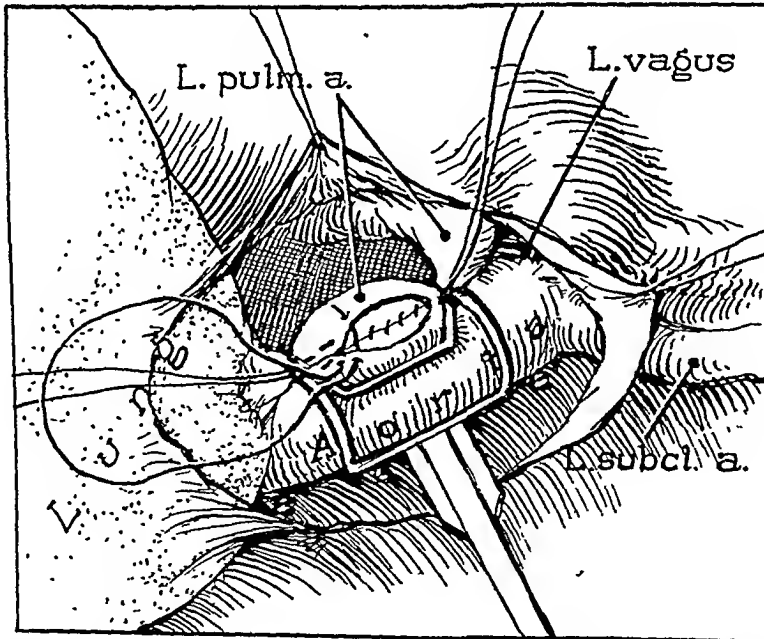
Fig. 10. Showing the operation as described by Potts, Smith and Gibson. The partial occlusion clamp is placed on the aorta and a side-to-side anastomosis is performed to the left pulmonary artery. The suture is pulled up as it is placed. The intima cannot be everted as well as when the thinner walled branches of the aorta are used.

In the original article by Blalock and Taussig (¹) the suggestion was made that it might be possible to anastomose the aorta to one of the two major branches of the pulmonary artery, but this procedure was discarded because of the danger to the lower part of the body attendant upon occlusion of the aorta and because one was less able to approximate the intimal surfaces in using the thicker and more friable aorta. Although the second objection remains, the danger to the lower part of the body has been obviated by the development of an ingenious clamp by Potts, Smith and Gibson(⁸), with which the aorta may be partially occluded while a side-to-side anastomosis is performed. Fig. 10 demonstrates the use of this clamp. When using this procedure care must be taken to limit the size of the opening in the aorta. It is our impression, and it is only an impression, that a side-to-side anastomosis of the aorta places a greater burden upon the heart than does the use of one of the branches of the aorta of a comparable size. We feel that, although this operation may be utilized in patients of any age, its greatest usefulness will be in small children and infants in whom the aortic branches are unusually small.

The principle underlying all of these variants is the same—namely, the by-passing of the point of obstruction to the flow of blood to the lung. The surgeon performing this type of work must be prepared to do any of the operations mentioned according to the indications and the conditions encountered. The same procedure does not fit all cases. There is always a systemic artery which may be used, but the pulmonary artery is often a limiting factor. In some children it is diminutive in size. In these cases it is easier to use the thinner walled subclavian artery than the aorta. If there is no pulmonary artery or if it is extremely small, one is obviously defeated. There seems to be an inverse ratio between the size of the systemic vessels and the pulmonary artery, and in children with a very large aorta, the pulmonary artery is apt to be small.

Our present ideas in regard to the type of operation to be performed on patients of various ages and sizes are as follows : The ideal age is between two and 12 years, inclusive. It is in this age group that the best results are obtained. Prior to this time, that is, in infants and children under two years of age, the diagnosis is more difficult, the mortality rate is considerably higher, and the anastomosis must be smaller. We do not know definitely whether the anastomoses increase in size with the growth of the patient. It is probable that many of the patients operated upon in the first two years of life will need another operation later, and, indeed, several of them have had such operations. It is our present policy to postpone operation in the first two years of life if there is thought to be a 50 per cent. chance that the patient will survive until his second birthday. If operation is decided upon, we operate on the side on which the aorta descends and use the subclavian artery if it is large enough ; if

it is not, we perform a side-to-side anastomosis with the aorta. In patients in the 2-to 12-year age group we operate upon the side opposite to that of the aortic arch and prefer to use the subclavian branch of the innominate in an end-to-side anastomosis. If this is impractical because of too great a distance between the systemic and pulmonary vessels or because of small pulmonary arteries, an end-to-end anastomosis is performed. The carotid and innominate arteries are used with great reluctance.

We know of no specific way whereby one may render patients older than 12 years more suitable for operation. In these older patients the mortality rate is slightly higher and the operation is more difficult because of the increase in the collateral vessels in the lung hilum and mediastinum, and the decreased elasticity of the arteries and the increased distance between the systemic and pulmonary arteries. In these patients and in younger ones who are more than five feet in height we make the incision on the left. When the aortic arch is on the left the subclavian artery is used, if possible ; if this is impossible, a side-to-side anastomosis is performed between the pulmonary artery and the aorta. If the aorta descends on the right, the subclavian branch of the innominate is used. This vessel is usually a long one and, as stated previously, the left pulmonary artery is higher than the right so that approximation is easier. Fig. 11 shows such an anastomosis completed.
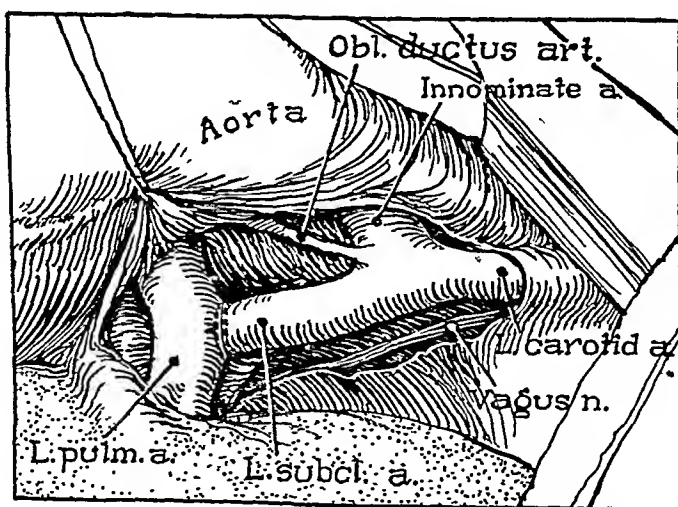

Fig. 11. Anastomosis of the left subclavian to the left pulmonary artery in a patient with a right aortic arch. Note the obliterated ductus arteriosus joining the pulmonary artery to the distal innominate. The operation is usually easier on this side because the left pulmonary artery is higher than the right.

The pre- and post-operative care of these patients is not complicated, but they do require frequent supervision, since a short time may mark a considerable change in their condition. Digitalis is given pre-operatively to the occasional patient with signs of decompensation. Venesections are not performed preparatory to operation. The fluid intake must be maintained to avoid dehydration and cerebral thrombosis. A child should receive at least 1,600 cc. of fluid a day and an adult at least 2,200 cc. The premedication is 1 mgm. of morphine per 10 pounds of body weight with 1/20th of this dose of atropine. In the majority of instances the anæsthetic is intratracheal cyclopropane and oxygen. In those patients in whom there is arrhythmia this is changed to ether and oxygen. The anæsthesia is as light as is consistent with a quiet mediastinum. Fluids are given in a quantity to match the estimated loss. Blood plasma is used unless the patient does not have polycythemia, in which case whole blood may be indicated. Any excessive loss of blood is replaced with whole blood. There are not infrequently short periods of bradycardia during the course of the dissection ; although a cause for concern, these usually respond to the administration of intravenous atropine.

Post-operatively, oxygen tents are used routinely for a day or so, depending on the patient's condition. Prophylactic doses of penicillin are administered. The intravenous drip begun at operation is continued until the patient is taking adequate fluids by mouth. The fluid intake is restricted slightly in an effort to prevent overloading the pulmonary circulation, but at the same time dehydration with its attendant cerebral thrombosis must be avoided. The usual volumes range from 80 cc. to 100 cc. per kilogram in infants to about half that volume in older children and even less in adults. Venesection is rarely resorted to, although it may be helpful in cardiac failure or pulmonary œdema. We do not customarily use anticoagulants, but rather reserve heparin for the patients in whom there appears to be cerebral thrombosis or thrombosis of the anastomosis. About half of the patients require thoracentesis for removal of the serosanguineous fluid which accumulates to some degree in almost all patients. By and large one must be as careful of over-treatment as of the opposite, and rest, perhaps with the help of sedation, is of considerable value, at least for the first few days.

Vascular Anomalies

Right aortic arch.—In approximately 140 of the 610 patients operated upon the aorta arched over the hilum of the right lung instead of the left, a condition termed a right aortic arch. It is unimportant as far as the patient's symptomatology is concerned but must be ascertained before operation in order that one may enter the correct pleural cavity. It should be remembered that the innominate is the first branch of the aortic arch and can be best reached through the plural cavity opposite that of the aortic arch. Almost invariably the operation is easier when

performed with a right aortic arch, for the pulmonary artery is a few centimetres higher on the left than on the right, and the left subclavian in such cases is usually a longer vessel. In about three-fourths of the patients with a right aortic arch an obliterated ductus arteriosus is found coursing between the left pulmonary artery and the left subclavian artery or the innominate at its bifurcation (Fig. 11). However, the ductus is not always on the right in such patients, and, in fact, Dr. John Jones has operated on the right for a patent ductus in a patient with a right aortic arch.

The usual course of the aorta distal to the arch is a continuation of the thoracic aorta to the right of the œsophagus. In some instances, however, the aorta runs behind the œsophagus and enters the left chest cavity for the remainder of its intrathoracic portion. This is termed a right aortic arch with a left descending aorta. One patient was recently operated upon who had the rare combination of a left aortic arch, a retro-œsophageal aorta, and a right descending aorta.

Retro-œsophageal subclavian artery.—In 26 patients, 12 of whom were operated upon on the right side, the subclavian artery to the extremity on the side opposite the aortic arch arose as the last branch of the arch. It coursed behind the œsophagus and trachea to enter the opposite pleural cavity. In most instances this condition is suspected by the presence of a persistent filling defect in the posterior wall of the œsophagus demonstrated by barium swallow and fluoroscopy. This arrangement offers no contraindication to the use of this vessel, and, indeed, it is often of greater length and is more easily approximated to the pulmonary artery than the normal subclavian branch of the innominate artery. In one patient in whom a retro-œsophageal subclavian artery was anastomosed to the pulmonary artery, there were suggestive signs of tracheal obstruction post-operatively. The child died as a result of cerebral complications, and at autopsy there seemed to be some œsophageal and tracheal compression by the " vascular ring " created by the anastomosis. Since that time we have been freeing these vessels and transposing them anterior to the bronchus on the operated side before performing the anastomosis. For some unknown reason the retro-œsophageal arteries are thinner walled than normal arteries and must be handled with greater care.

In one case the innominate artery arose from the distal part of the aortic arch and was retro-œsophageal in its course prior to giving off its branches.

Absence of the innominate artery.—Abnormal arrangements of the origin of the great vessels arising from the aortic arch occur so frequently that, like a right aortic arch, they can hardly be called anomalies. All four vessels may arise from the arch independently, or one subclavian and both carotid arteries may come from a single trunk. A thyroid ima

artery may arise from the aortic arch, the innominate, or the carotid artery. In the latter two instances this is of some importance since it may be torn in freeing these vessels. Whenever one doubts the identity of systemic vessels, help is obtained by occluding them and having the anæsthetist feel the various pulses. In several instances we have failed to appreciate the presence of a retro-œsophageal subclavian artery and have used the carotid.

In one patient it was noted pre-operatively that the left carotid pulsation was weaker than the right. At operation on the left side with a right aortic arch no innominate artery was found. In its place a fibrous band ran from the left pulmonary artery to the site of the normal bifurcation of the innominate. The collateral circulation was such that vigorous back pulsations occurred on occlusion of either the carotid or the subclavian artery, and the child was improved following anastomosis of the side of this bifurcation to the side of the left pulmonary artery.

Double aortic arch.—In rare instances the right aortic arch may undergo its full development without disappearance of the left aortic arch. Under these circumstances there may be tracheal or œsophageal obstruction in some patients. The origin of the great vessels from the two arches is variable, but from the standpoint of embryology it would be expected that at least the four main vessels would arise independently. It may be possible to diagnose the condition before operation by fluoroscopic evidence of œsophageal compression from both of the arches. We are aware of only one patient in this series in whom there was a double aortic arch associated with a tetralogy of Fallot. The patient did well in her early post-operative period, but died a fortnight later. At autopsy a large ball thrombus was found in the left ventricle, and it was felt that this had suddenly occluded the left ventricular outlet.

Single pulmonary artery.—In nine patients it was demonstrated at operation or autopsy that there was no branch of the pulmonary artery to one of the lungs, the diminished function of the lung being maintained by bronchial and collateral vessels. This condition can be suspected at the time of operation by the failure of the patient to tolerate occlusion of the pulmonary artery or by the rise in pressure of the proximal segment when it is occluded distally. Of course, when one operates on the opposite side no pulmonary artery will be found. If one is aware of the condition, it might be possible to occlude the artery partially, much as the aorta is occluded in the Potts operation, but it is probable that the risk would be too great to warrant such a procedure.

Functional truncus arteriosus with a blind pulmonary artery.—There have been several patients in whom there was no connection between the pulmonary arteries and the heart, except through collateral and bronchial arteries. In one of these the right pulmonary artery at its bifurcation

and distally was of normal size and configuration, but only a fibrous strand existed to represent the proximal portion of the pulmonary artery. The pulmonary circulation was effected by a large retro-œsophageal artery, which entered the posterior aspect of the hilum of the lung. An anastomosis was begun to the side of the bifurcation of the pulmonary artery, but the child succumbed as this was being completed.

Bilateral superior venæ cavæ.—This condition is probably not rare, and is now being demonstrated with unexpected frequency by the greater employment of angiocardiography in puzzling cases. This arrangement of the venous return is, of course, not apparent at the time of operation, although persistent left venæ cavæ have been seen fairly often. When a left vena cava persists it usually enters the right auricle through the coronary sinus, since the cava and the sinus are the remnants of the left duct of Cuvier. In one patient, however, it was shown by angiocardiography that a right superior vena cava entered the right auricle and a left superior vena cava entered the left auricle. No treatment has been directed at the anomalous venous return, and in no case has it seemed to be of significance in causing cyanosis.

Other anomalies of the systemic veins.—In several patients in whom a left thoracotomy was performed, both superior and inferior venæ cavæ were encountered. The latter arched behind and over the hilum of the left lung to join the superior cava. The site of opening into the heart was not determined. In creating an artificial ductus arteriosus in such patients care must be taken not to constrict either of these vessels. The anastomosis is best constructed so that after completion it will lie medial to the vessels.

In one patient the left innominate vein was posterior to the innominate artery before joining the right innominate vein to form the superior vena cava.

Anomalies of the pulmonary veins.—One frequently sees pulmonary veins emptying into the right auricle, or the right, or a persistent left superior vena cava. The surgical significance of these in pulmonary surgery of patients without congenital heart disease has been shown by Brody (9), Brantigan (10) and others. Such anomalies are more frequent in patients with congenital defects. It has never seemed advisable to ligate these veins or to attempt to anastomose them to other structures.

Results

A total of 610 cyanotic patients have been operated upon in whom a pre-operative diagnosis of an inadequate pulmonary blood flow had been made by Dr. Taussig and her associates, Dr. Bing, with his physiological methods, and others. With the exception of 15 operations performed at Guy's Hospital, London, and Hôpital Broussais in Paris, these have all been done at The Johns Hopkins Hospital by members of the surgical

staff.* A second operation has been performed in several of these patients. In this total number there have been 108 deaths, an overall mortality rate of 17·7 per cent. No known deaths are excluded. Twenty-seven patients died at the time of operation, 68 while in the hospital during the post-operative period, and 13 after leaving the hospital. In a few of these patients only an exploration was performed as the pulmonary artery was not found or was not suitable for an anastomosis. In some the diagnosis was in error ; for example, there were seven fatal cases where there was transposition of the aorta and pulmonary artery without pulmonic stenosis. A few of the deaths were attributable to unrelated causes such as meningitis, pneumonia, and so forth, after discharge from the hospital.

Of the 27 patients who died during the operation, 12 died in the course of exploration alone, either because the pulmonary artery was inadequate for an anastomosis or because of arrhythmia before the anastomosis could be attempted. We are not sure of the cause of death in these patients, and there probably is no single cause, but cardiac and cerebral anoxia seems to play the most important role.

Of the 68 patients who died in the hospital after operation, 24 died of cerebral complications, including cerebral thrombosis, anoxia, or brain abscess in a few : 16 died of cardiac failure or pulmonary œdema ; hæmorrhage was the primary cause of death in eight, and thrombosis of the anastomosis in an equal number ; three died with respiratory complications.

There have been 13 patients who died after leaving the hospital. Some of the deaths were not related to the operative procedure. The causes were varied and included pneumonia, cardiac failure, meningitis, cerebrovascular accidents, and coronary occlusion.

The mortality rate depends to a considerable extent upon the principles which one adopts in regard to the indications for operation. We have felt that any patient should be operated upon in whom available methods point to the diagnosis of inadequate pulmonary circulation. This has included many patients who were extremely poor operative risks, and, in fact, there have been a number of patients who died while in the hospital awaiting operation. Some of these extremely poor-risk patients, however, had good results following the completion of the operation. One's mortality rate will be lower if he selects only those patients who are in the age group of two to 12 years, without extreme incapacity or a history of cerebral accidents, with a small heart, a good systolic murmur,

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* This includes Doctors Longmire, Shumacker, Scott, Hanlon, Bahnson, Duncan, Clay and Cantrell, who performed a total of 149 operations.

and the other features of a typical tetralogy of Fallot. On the other hand, the number of deaths will obviously increase if indications are extended to include patients with a rotated heart, arrhythmia, cardiac enlargement, evidence of cerebral damage, and pulmonary atresia as suggested by the absence of a systolic murmur, and infants and older adults. In selected cases in which one is able to perform the preferred anastomosis the deaths are fewer. Of the 433 patients in whom a subclavian-pulmonary anastomosis was performed end-to-side, 10·4 per cent. died, and in a few of these there was an error in diagnosis. In one sequence we operated upon 44 consecutive patients without a death.

The end of the subclavian artery has been anastomosed to the end of the pulmonary artery in 38 cases, with 15·7 per cent. mortality In the majority of these patients the indication for the end-to-end anastomosis was a small pulmonary artery. Contrary to opinions held at the beginning of this work, the use of the innominate or carotid artery for an anastomosis is seldom necessary. The use of the innominate artery in 49 patients was associated with a 30·6 per cent. mortality and of the carotid in 34 patients with a 23·5 per cent. mortality. Admittedly these patients are often infants or very sick children who are poor risks, but the use of these vessels adds to the danger of the operation. The aorta has been anastomosed to the left pulmonary artery in two patients, one of whom died as a result of pulmonary œdema. Exploration alone was done in 24 patients with four deaths.

The subclavian artery has been ligated in about 555 patients without difficulty. The ligature is usually placed just distal to the branching of the vessel. A block of the sympathetic nerves has never been necessary. The arm and hand supplied by this vessel are customarily cooler for several days after the operation, and no pulse is felt for a considerably longer time. The patients often state that the arm feels weaker for several days, but there has never been a significant interference with function.

Most of the patients who survive the operation are improved. This improvement varies in degree from that of patients who are considerably restricted to those who have no limitation of their activities. In patients with a satisfactory result the colour improves rapidly following the completion of the anastomosis. The oxygen saturation rises, the polycythemia diminishes and may disappear, and the clubbing of the digits regresses. The pulse pressure increases, and there is a soft continuous murmur audible over the chest. The most gratifying alteration is the increased capacity for exertion. Some patients who previously were limited to a few steps can now walk miles, and many are able to exercise normally and equal other children of their age in activity. The point must be stressed, however, that the interval since operation is as yet too short to allow an accurate evaluation of the final results.

Summary

The indications for operation and the operative procedures performed upon 610 patients with congenital heart disease of the cyanotic type are described. The anomalies of blood vessels which have been encountered are enumerated, and a brief summary of the results is given.

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ELECTION OF PRESIDENT AND VICE-PRESIDENTS—8th JULY, 1948

Lord Webb-Johnson was re-elected President for the eighth year. Mr. L. E. C. Norbury was re-elected Vice-President, Mr. Zachary Cope was elected Vice-President for the ensuing year.

ACUTE ABDOMINAL EMERGENCIES

Sir Lancelot Barrington-Ward, K.C.V.O., F.R.C.S.,
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IN NO FIELD is human endeavour more completely rewarded than in the successful treatment of an acute abdominal emergency in the child. In most cases we are not dealing with one of the end products of modern civilization. We are set to save the life of someone inherently healthy, the victim of a pathological accident, and one likely, if he survives, to be a healthy and useful member of his generation. The study is rendered even more satisfying by reason of the delicacy and refinement required both in the diagnosis and treatment to determine a happy issue.

It must be taken for granted that any surgeon dealing with acute illness in the child must be at heart at least half a physician. The border line between medicine and surgery in Pædiatrics is very faintly drawn and in the diagnosis of acute abdominal emergencies there is no line at all. The surgeon must be as alive as the physician to distinguish between a high retrocæcal appendicitis and a right basal pneumonia with pleurisy, or between volvulus of the mid-gut and an intense acidosis, or between an inflamed appendix and an early paratyphoid infection. The subject is large for one lecture and I therefore propose to omit the many interesting pathological conditions which are found at, or shortly after birth. Volvulus neonatorum, the atresias, and exomphalos, strictly speaking, are surgical emergencies but are best considered separately. The urgent abdominal surgery whose consideration is my present task can be classified on the basis of age-incidence or pathology. It is always well in approaching a diagnostic problem to have some idea of the likely possibilities. Certain diseases have a fairly regular age-incidence. In the first two years of life congenital malformations, faulty development of the mid-gut for instance, may be responsible, or a peculiarity of structure at this age such as the predominance of lymphoid tissue known as Peyer's Patches which is a possible factor in the origin of Intussusception. After the age of two the picture changes. Appendicitis takes a rising toll and intestinal obstruction and peritonitis from acquired causes become more frequent.

Abdominal emergencies can also be considered on a pathological basis. They are in the beginning either obstructions or inflammations and very rarely torsion of a solid viscus.

One of the first steps in diagnosis is to determine to one's own satisfaction

which of the two pathological processes are predominant. I need hardly remind you of the clinical features. In *acute obstruction* the early symptons are invariably colicky central abdominal pain, sometimes vomiting, and interference with bowel function. The signs are often vague, some general tenderness, no true rigidity, and slight distension at first, becoming more evident as the illness develops. In *inflammation* pain is gradual, continuous and progressive. It is referred locally to the seat of infection. The abdominal muscles are held voluntarily rigid at first but later the rigidity becomes involuntary and is more marked over the affected area. The temperature and pulse rate vary a good deal and may be misleading. A high temperature, one hundred and three degrees for instance, may be evidence against a surgical lesion. The pulse rate often does not rise in the early stages of an illness, but its ratio to the respiratory rate is always important.

An accurate diagnosis is the essence of successful treatment, and accurate diagnosis can only be made by the consideration of early symptoms. In the infant this information has to be obtained by a close cross-examination of the mother or nurse. The expenditure of some time and patience in extracting details is always worth while.

To present the Abdominal Emergencies in some order I have taken their frequency in my own hospital and private practice in the pre-war decade.

As you would expect *Acute Appendicitis* forms nearly half the number. I need not stress the importance of early operation in the child. The attack in my experience always begins with obstruction of the appendix and if that obstruction is not speedily relieved, death of the organ ensues with all the complications of peritoneal infection. The right time to operate is while the appendix is still intact, that is to say within twelve hours of the onset, if possible. If an accurate history can be obtained, an early diagnosis is simple. The central abdominal pain of a colicky type with perhaps an initial vomit : a slight rise of temperature and pulse rate, or none : tenderness over McBurney's point : localized rigidity, voluntary at first, later becoming involuntary over a wider area : such a picture can leave no cause for doubt.

Difficulties begin when the child is seen late in the attack, where the appendix is concealed in the pelvis or in a high retrocæcal position or where general peritonitis clouds everything. The sensitive parietal peritoneum is a great help to the surgeon. An inflamed appendix lying against the anterior abdominal wall produces local signs early and gains early recognition. If the appendix is not in relation to the parietal peritoneum as the result of adhesions or anatomical position, abdominal tenderness and rigidity may be absent. If it is in the pelvis it is likely to irritate the bladder or rectum and this may mislead or help. If it is retrocæcal and high in position, irritation of the diaphragm may simulate a basal pneumonia and only the precise history of the onset and a correct and subtle reading of the physical signs will allow a true diagnosis.

Treatment. A waiting policy, expectant treatment, is only justified in one set of circumstance in the child and that is when a definite localized mass is present in the Right Iliac Fossa with moderate constitutional symptoms. Resolution or suppuration may be awaited provided close watch is kept on the march of events and facilities are at hand for immediate action if there is any deterioration in the local or general condition. A spreading or general peritonitis always demands immediate operation. Immediate does not mean the exclusion of those preliminaries with which you are now so familiar and which have so profound a bearing on mortality figures. The stomach is emptied and kept empty by a nasal catheter : an intravenous drip is set up to rest the alimentary canal, to combat dehydration, to restore the salt balance and to increase the glycogen reserve. The operation should always aim at the removal of the appendix. The peritoneum can stand a sudden severe infection but not a continuing one. In the presence of frank pus pelvic drainage is essential for forty-eight hours. Penicillin and chemotherapy are adjuvants not to be neglected, even though the predominant organisms may not be sensitive. In the after-treatment I am still a believer in the importance of withholding the taking of anything by the mouth until the pulse and temperature and general abdominal condition show that the peritonitis is controlled, a practice which I have sedulously followed since 1911 without regret. By rectal or intravenous administration the balance of fluids and salts can be controlled and no work need be put on the inflamed viscera. With such a regime, with adequate and regular doses of morphia, the patient can be kept in comparative comfort, immune from distressing complications of which ileus is the most formidable.

Intussusception comes next in frequency. It is the most dramatic of all the abdominal emergencies. It is unheralded, it smites an apparently healthy child and it is fatal if the diagnosis is missed and treatment is delayed. With early diagnosis and immediate operation, no case should be lost. Diagnosis, therefore, is the all-important factor. Nothing is simpler than the typical case. A healthy infant, more often a boy (sixty-five per cent.), under the age of two (seventy per cent. under one year of age) is suddenly seized with severe abdominal pain. This is demonstrated by the cry, the shocked appearance—a white elderly anxious look, and the drawing up of the legs with the spasm. An attack lasts but a few moments and after a lull is repeated. There may be a vomit and a normal bowel action. Between the attacks the infant lies exhausted and listless. After the spasm, blood and mucus may be passed per rectum. On examining the abdomen there is no distension but a lump may be felt in the line of the colon. This lump may be observed to harden with each attack of pain. On rectal examination the invaginated bowel may be felt in the lumen of the rectum or through the rectal wall and the finger may be stained with blood. Such is the common picture and if every case of Intussus-

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ception presented all these features, few would escape exact diagnosis and early treatment.

Unfortunately there are exceptions. The early symptoms, pain and shock, may not have been reported, blood may not be passed until late in the illness or not at all. The lump may not be felt ; it may be hidden by the costal margin or the lusty abdominal muscles of a strong infant may conceal it. In any or all of these contingencies, the diagnosis is missed and the golden moment is lost. Intussusception must not be considered as an obstruction : to wait until abdominal distension, absence of bowel action and persistent vomiting are established, is to condemn the patient to the risk of an irreducible invagination.

Differential Diagnosis. I have seen too often a lump in the Right Iliac Fossa diagnosed as Intussusception without sufficient reason. Appendicitis in infancy is not unknown although rarely diagnosed. After a few days of abdominal storm with pain, vomiting and perhaps a moderate pyrexia a lump is found in the right lower abdomen. Its hardness, fixity and lateral position, and also its tenderness if this can be elicited should exclude intussusception. Abdominal tuberculosis may present such a tumour but its recognition does not follow any severe abdominal upset.

Purpura and Hæmophilia raise greater difficulty because either condition can not only imitate intussusception in the broad clinical picture, but can produce an invagination through hæmorrhagic infiltration of the submucous coat. I have recently had under my care a boy of four-and-a-half, known to be the subject of hæmophilia. He was admitted to hospital with abdominal pain, bleeding from the rectum, and a mass in the lower abdomen. I was asked to see him six days after the onset of illness. There was no abdominal distension, the bowels reacted to enemata and the lump was stationary in position but slowly enlarging. At this stage if an intussusception had been present, obstruction would surely have been present and I formed the opinion that a retroperitoneal hæmorrhage was responsible. 'Despite repeated transfusions the child died and autopsy confirmed this diagnosis.

In cases of doubt, if the general condition warrants, the value of a Barium Enema should not be forgotten. It takes but little time and will give conclusive evidence. In the majority of cases clinical judgment alone is sufficient.

Treatment. From time to time non-operative methods have been advocated in the treatment of intussusception. The injection of air or fluids may affect considerable retrogression of the intussusception but there must always remain some doubt, even with a skiagraph, of absolute reduction. The problem lies in the last few inches and the loss of valuable time together with the uncertainty makes these procedures in my opinion undesirable. I believe operation should be performed in every case, without delay. The mortality rate depends on the duration of the illness ; early operation is a simple matter ; delayed operation presents great technical

difficulties. After adequate preliminary treatment, gastric suction and parenteral administration of fluids, the abdomen is opened through or · by displacement of the lower right rectus muscle and the intussusception is manipulated manually to its origin in the ileocæcal region. Complete reduction is a simple matter within twenty-four hours of the onset but with every hour that passes it becomes more difficult. Every effort short of gross trauma should be employed to reduce the engaged mass. Equable firm pressure applied with a hot swab with very gentle traction on the entering tube should be tried for several minutes. One or two minor splits of the peritoneal coat need not cause alarm, they can easily be repaired by fine catgut Lembert sutures after reduction, but as soon as it is realized that reduction is impossible, valuable time must not be lost and resection must be undertaken. Undue persistence has cost many lives for under an anæsthetic the infant loses ground rapidly.

The surgeon follows his predeliction. I prefer an immediate resection with side-to-side union of ileum and transverse colon. Others prefer a Mickulitz type of operation. The published figures of recovery vary but little. The mortality is necessarily high and in the future can only be avoided by early diagnosis and early operation.

Intestinal Obstruction. The causes of Intestinal Obstruction are legion and many are of great pathological interest. It is however rather disturbing to find that in more than half of the cases a previous abdominal operation has been responsible. Acute appendicitis is the chief offender because it is the most common operation, but operation for intussusception or any abdominal condition in the child may leave a band to trap the small intestine or an adhesion to a coil to induce volvulus. It is therefore important in any case of suspected intestinal obstruction to get an accurate previous history and to take careful note of any abdominal scar. If taken early, the surgical remedy of such obstruction is usually simple. Next in frequency come developmental errors of the mid-gut and its mesentery. The mal-rotations are rare and are best considered under diseases of the new born but non-rotation in varying degrees is more common and often does not give rise to symptoms until later childhood, or even adult life. The most frequent type is where normal rotation has failed and the small intestines occupy the right half of the abdomen and the large intestine is left. No pathological results occur except through abnormal adhesions. Ladd has shown that bands crossing the duodenum from the lateral abdominal wall to the abnormally placed high and central cæcum obstruct the duodenum. If the posterior parietal peritoneum is incised to the right of the cæcum, the large intestine moves to the left and leaves the duodenum free. In another group of cases rotation may have been normal but fixation which completes the third stage has been incomplete and the small intestine and proximal colon are suspended on a · narrow pedicle, the superior mesenteric artery only, without any of the normal posterior peritoneal support. An individual with this disability

is in constant jeopardy of his life because rotation, usually clockwise, can occur at any moment, leading to torsion and infarction of the whole loop. Such abnormal rotation is not always complete and minor degrees may undergo spontaneous recovery. As in volvulus neonatorum the first effect of the rotation is brought to bear on the duodeno-jejunal junction and the early symptoms are those of duodenal obstruction. The abdomen is flat at first because the intestines are collapsed and attention is thus diverted from the true etiology. The attacks are sometimes recurrent and incomplete and a diagnosis of acidosis or cœliac disease has sometimes been made in error. If it is possible to diagnose the anatomical fault before a final catastrophe, a fixation operation on the ascending colon (Waugh) may obviate the risk of a massive volvulus.

A congenital hole in the Mesentery may lead to intestinal obstruction (Fig. 1.) It is usually ileal with well-defined margins and is the most frequent of the internal hernias. It is doubly dangerous because the loop which passes through not only may become gangrenous itself, but by pressure may lead to the death of the encircling bowel. A double resection may be necessary.

Cysts of the Mesentery are usually discovered by reason of their size and gradual interference with bowel function, but on occasion they cause acute intestinal obstruction without previous diagnosis. Distinction must be made between duplication of the intestine and the true cyst of the mesentery. The duplications lie in close relation to some length of bowel (Fig. 2) and are less likely to cause volvulus than a solitary cyst which by its weight has probably elongated the mesentery and made it more liable to abnormal rotation. The cyst may cause obstruction mechanically but volvulus is more often the immediate cause (Fig. 3). In the treatment of acute obstruction it may be possible to undo the volvulus and shell out the cyst from the mesentery but more usually, especially in the closely attached duplications, excision of the loop is required. Marsupialization has little to commend it. I have seen several cases of recurrent intestinal obstruction follow this technique necessitating a difficult and complicated operation for its relief.

Meckel's Diverticulum can cause an abdominal emergency in a variety of ways. It is a dangerous structure. No doubt many people go through life with a short patent diverticulum without coming to any harm, but if the diverticulum is attached to the umbilicus congenitally, or by inflammation to the intestine or parietes, intestinal obstruction is an almost certain sequel. The diverticulum may be narrowed at its point of origin, and stasis may lead to inflammation, gangrene and perforation, very similar to the fate of the Appendix Vermiformis. A mildly inflamed Meckel's Diverticulum may irritate the bowel, disturb peristalsis and induce intussusception in which it may or may not be included. But the most interesting pathological accidents are associated with the heterotopic structures found quite frequently. Typical gastric mucosa may line the
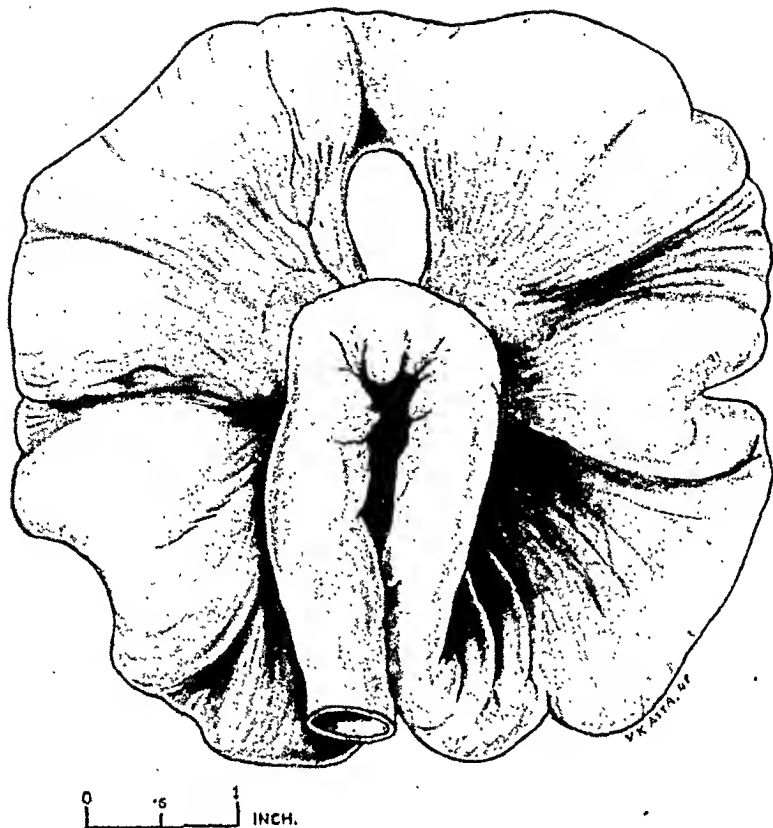
Fig. 1.
Hole in Mesentery. Strangulation of Small Intestine. Resection. Pathological Museum, Hospital for Sick Children, Great Ormond Street.
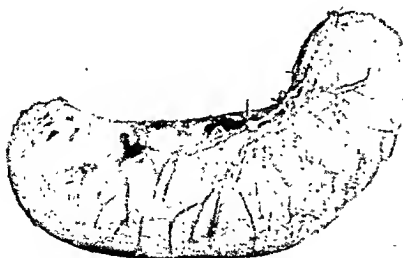
Fig. 2.
Duplication of intestine causing intestinal obstruction in a child of three months. Pathological Museum, Hospital for Sick Children, Great Ormond Street.

Fig. 3.
Mesenteric Cyst causing intestinal obstruction. Pathological Museum, Hospital for Sick Children, Great Ormond Street.

Fig 4

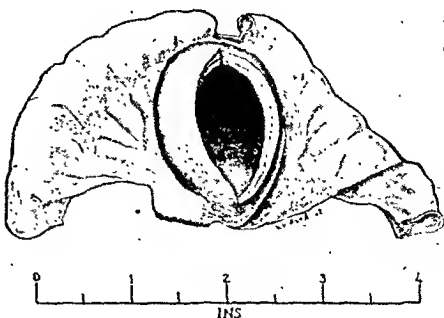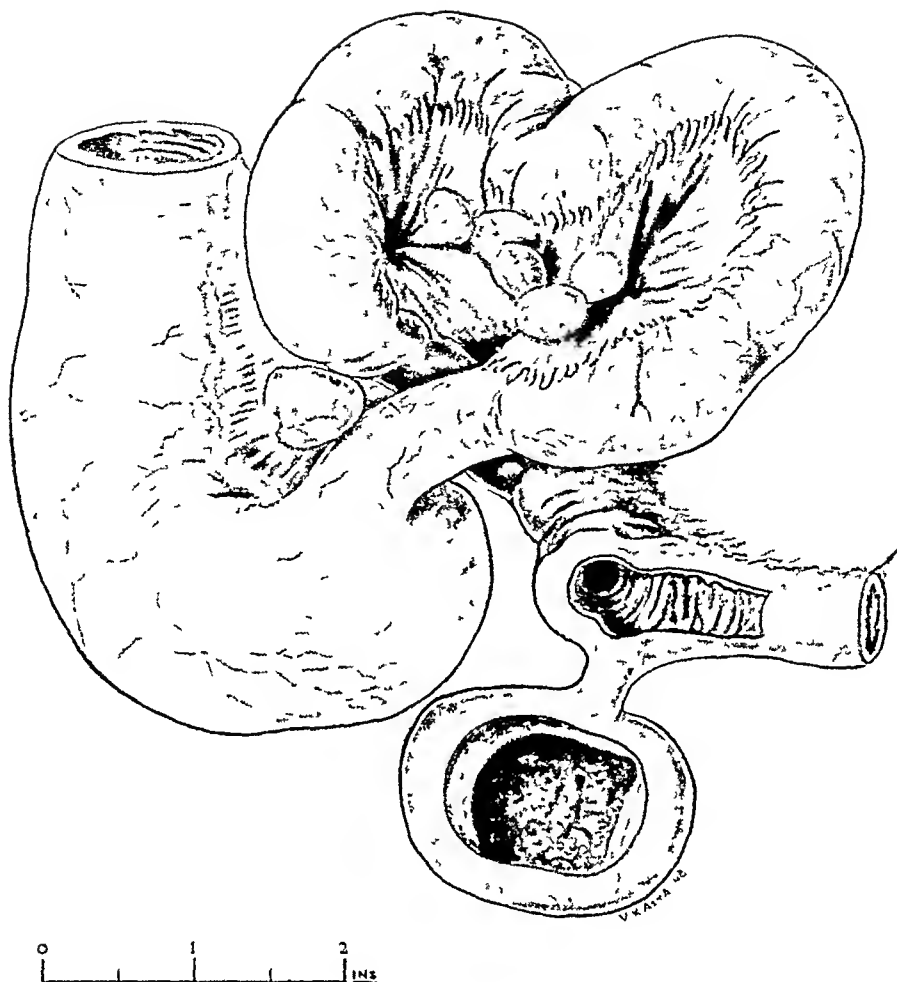Meckel's Diverticulum with Gastric Mucosa. Volvulus necessitated resection
Pathological Museum, Hospital for Sick Children, Great Ormond Street.

Fig. 5
Cholecystitis and stone removed from a child aged four.

whole or part of the diverticulum (Fig. 4). Gastric juice is secreted and can cause a peptic ulcer. This ulcer may perforate but more usually it declares itself by hæmorrhage, which if untreated may be fatal. The possibility of a peptic ulcer associated with a Meckel's Diverticulum should be remembered when a child or adolescent passes considerable quantities of bright red or slightly darker blood by the rectum accompanied perhaps by some central colicky pain and when no other source of bleeding can be detected.

Primary Peritonitis. In my experience streptococcal and pneumococcal peritonitis are becoming more rare. This may be due to our greater control of streptococcal and pneumococcal infections by chemotherapy and penicillin.

I propose to consider them together as there is no discernible difference in their clinical features, and without bacteriological examination it is impossible to differentiate between them. Those cases are excluded where the peritonitis is a complication of an obvious coccal lesion and is only part of a general septicæmia. Thus, it may be a complication of pneumonia, pericarditis, mastoiditis or osteomyelitis. To the surgeon interest lies in those cases when the peritonitis appears to be primary and when no obvious source of infection in any other system can be found. Such cases present difficulties in diagnosis and treatment.

The child presents the symptoms of an abdominal illness which may begin with a rigor. Complaint is made of severe general constant abdominal pain. There may be vomiting. The temperature is high, higher than is commonly found in a septic peritonitis, 103-4 degrees or even 106 degrees. The abdomen is doughy, everywhere tender, with some general rigidity, not so marked as in an appendix peritonitis. There is often a high leucocytosis, 20-30.000. It is impossible to be absolutely certain of the diagnosis, although the somewhat atypical features may suggest the possibility of an idiopathic peritonitis. Peritoneal puncture with immediate examination of a slide has been suggested to determine the organism, a method which I have tried without much conviction. Peritonitis due to appendicitis is so much more common and so dangerous that I prefer to exclude it by operation.

Under premedication and local anæsthesia the abdomen is opened by a short right rectus incision. The parietal peritoneum will appear injected and slightly oedematous. Thick yellow non-odorous pus appears between the slightly distended and reddened intestine and patches of fibrous lymph are found between the coils. The ileocæcal region is inspected and the absence of any intensification or alteration of the infection excludes the appendix. A somewhat red appendix, part of the general peritonitis, should not condemn it to removal. If the effusion is considerable, a 24-hour drain is desirable : if it is small in amount, the abdomen is closed. If, however, the presumptive diagnosis is at fault and stinking pus leads to the appendix area, a general anæsthetic

should be administered, and the appendix is removed, and adequate drainage instituted.

In a primary peritonitis immediate bacteriological examination of the pus will confirm the diagnosis, but there should be no delay in administering penicillin, and the appropriate sulpha drug, preferably in soluble form.

Peritonitis from the perforation of a foreign body is a possibility to be considered in any obscure abdominal emergency. I have met with this accident several times, and it presents a puzzling picture. Perforation of the duodenum by an open safety pin, perforation of the appendix by a needle, and perforation of the small intestine in a child of two by a splinter of wood come to mind. There is usually no history of the ingestion, and usually the process of perforation is slow enough to allow defensive adhesions with local suppuration to form. A mixture of inflammatory and obstructive signs, therefore, are present, and the underlying cause is only found after exploration.

To complete the picture of abdominal emergencies certain rare occurrences should be mentioned. Most of them are of an adult pattern and come as a surprise to the pædiatric surgeon. Perforation of a peptic ulcer, gastric or duodenal, has been recorded often.

Duodenal ulcer is not infrequent in infancy. It is rarely diagnosed, although if suspected a Barium Meal will confirm the diagnosis. Hæmorrhage and perforation are constant risks and most museums contain illustrative specimens. The clinical features and treatment differ in no way from the adult picture.

Acute Cholecystitis with or without a calculus can happen at any age. The symptoms and signs do not vary from the adult form. If a stone is present, the possibility of acholuric jaundice must be remembered, Fig. 5 shows an inflamed gall bladder and stone which was removed after the subsidence of an acute attack from a child aged four who was suffering from Hæmolytic jaundice. Splenectomy was performed at the same time with a satisfactory recovery.

Ovarian Cysts—simple, dermoid, or malignant—are by no means uncommon in children, and are met with at all ages, even in infancy. Torsion may occur before general features such as abdominal enlargement have drawn attention to the condition. Abdominal pain and severe vomiting, without alteration of the intestinal functions, are certainly suggestive, and if a tumour can be palpated through the abdominal wall or rectum, the diagnosis is strongly supported.

ABNORMALITIES OF THE SKELETON IN CHILDREN

Lecture delivered at the Royal College of Surgeons of England
on
15th June, 1948
by
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THE VARIOUS FACTORS which contribute to the formation of normal bone are, no doubt, well known to you. The cartilage cells, osteoblasts and osteoclasts, the periosteum, adequate supplies of calcium and phosphorus, vitamins, particularly D, and the endocrines—the pituitary and the parathyroids are outstanding—all play their part in the development and growth of the normal skeleton and in maintaining the strength and solidarity of the bones when formed. We are familiar with many conditions which result from failure of one or other of these to play its part, and are able in some cases to correct the error : there are others, however, in which, though we can see where things have gone wrong, we are entirely ignorant of the cause of the error. This is particularly true of the Congenital Development Errors, and it is with these that I propose to deal in particular. Jansen (1921) suggested amniotic pressure as the cause of many of them, the particular type produced depending on the moment in fœtal life at which the pressure became injurious, the parts exhibiting the most active growth at this moment being chiefly affected. This theory has not been generally accepted.

It is amazing how true to type our bones grow. Though shape and structure are influenced by the stresses and strains to which a bone is subjected, it possesses from the first an inherent capacity for developing an approximately normal shape. A chick's femur cultivated *in vitro* will grow, and even develop condyles, in spite of being completely isolated (Fell, 1929). Since this can happen there should be no difficulty in believing that a femur of an achondroplasiac, for instance, has meant from the first to develop the shape and form peculiar to this condition : there is no need to seek for a factor which has disturbed the growth which had every intention of following normal lines. It is a striking fact that the skeleton of achondroplasiacs, with few exceptions, are singularly true to type.

In some conditions the skeleton as a whole is affected, while in others the distribution of the changes is more limited, though they are sufficiently widespread in most cases to warrant our attention to-day. For instance, in diaphyseal aclasis the number of exostoses varies enormously : there may be only one or there may be as many as a thousand associated with gross malformation of the metaphyses of most of the major long bones, and with a definite degree of dwarfism. In the following classification

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will be found all the more important conditions affecting the skeleton in childhood and adolescence.

TABLE I.

1. CONGENITAL DEVELOPMENT ERRORS. (Primary Genetic Errors)—
   Osteogenesis imperfecta.
   Osteopetrosis. Melorheostosis.
   Diaphyseal Aclasis.
   Dyschondroplasia.
   Dysplasia Epiphysealis Multiplex.
   Dysplasia Epiphysealis Punctata.

   Chrondro-Osteo-Dystrophy
        (Morquio-Brailsford).
   Achondroplasia.
   Cranio-Cleido-Dysostosis.
   Arachnodactyly.
   Osteopoikilosis.
   Ateleiosis (Sexual).

2. ACQUIRED AFFECTIONS OF UNKNOWN ORIGIN—
   Polyostotic Fibrous Dysplasia. (Multiple Diffuse Fibrosis of Bone).

3. DUE TO ERRORS IN DIET AND METABOLISM—
   Scurvy.
   Rickets.
   Cœliac Rickets.
   Renal Rickets.

   Schüller-Christian Disease.
   Gaucher's Disease.
   Gargoylism.

4. DUE TO ENDOCRINE ERRORS—
   Gigantism (Pituitary).
   Progeria.
   Ateleiosis (Asexual).

   Cretinism.
   Hyperparathyroidism.
   Simmonds' Disease.
   Fröhlich's Syndrome.

   Hypogonadal or Eunuchoid Gigantism (or Infantilism).

5. DUE TO INFECTIONS AND TOXÆMIA—
   Congenital Syphilis.
   Hypertrophic-Osteo-arthropathy.

6. MULTIPLE NEOPLASMS—
   Chloroma and Leukæmia.

There is a condition, described in 1945 by Caffey and Silverman, which attacks infants and is appropriately named Infantile Cortical Hyperostosis. It appears to be inflammatory in origin, and recovery seems to be the rule.

Included under the heading of Congenital Development Errors are some conditions in which clinical signs are not obvious at birth and only develop later, but which, nevertheless, result from a Primary Embryonic Error. The Morquio-Brailsford type of chondro-osteo-dystrophy is an example, the characteristic features of which are rarely apparent before the age of four. In so-called osteogenesis imperfecta tarda the first fracture may not occur till some years have elapsed after birth. A child with intensely blue sclerotics had her first of many fractures at the age of 7, yet the error in development was undoubtedly present at birth. In Table II will be found the Congenital Development Errors, with three omissions, arranged according to the nature and chief site in the individual bones of the changes characteristic of the various conditions.

TABLE II.

CONGENITAL DEVELOPMENT ERRORS.

(a) Affecting chiefly the *Size and shape* of most of the Bones.
Achondroplasia.
Chondro-osteo-dystrophy (Morquio-Brailsford).

(b) Affecting chiefly the *General Texture* of the bones.
Osteogenesis imperfecta.
Osteopetrosis.

(c) Affecting the *Development of only some Bones*.
Cleido-cranio-dysostosis.
Arachnodactyly.

(d) Affecting principally the *Metaphyses*.
Diaphyseal Aclasis (Multiple Exostoses).
Dyschondroplasia (Multiple Enchondromata).

(e) Affecting principally the *Epiphyses*.
Dysplasia Epiphysealis Punctata and Multiplex.

Before discussing the essential characteristics of some of the conditions named in these tables, let us consider a feature which is common to many of them, namely, dwarfism. By dwarfism is meant a reduction of the stature below what is considered to be the lowest limit for a normal individual of a given age. Infantilism, on the other hand, implies the retention of childish characteristics, mental, sexual and physical, and, therefore, the sufferer may be dwarfed, in spite of the fact that the epiphyses may fuse late if at all.

Dwarfism may be due to diminished growth of the bones or to deformities, or to a combination of the two. The centres for the epiphyses may appear late and the rate of growth be retarded, or on the other hand the epiphyses may fuse early so that growth ceases too soon. Dwarfism may be the chief and most important feature of a case, or may form no more than one sign, perhaps the least important sign, of a particular abnormal condition. The skeleton as a whole may be affected to a fairly equal extent as in most of the professional midgets (sexual type of ateleiosis), in diaphyseal aclasis, and in many cases of osteogenesis imperfecta in which deformities following fractures are only partly responsible for the reduction in height. Though the whole skeleton is affected to some extent the dwarfism may be more marked in the limbs than the trunk—the micromelia or short-limb type familiar in achondroplasia. On the other hand the trunk may be more affected than the limbs, as in chrondro-osteo-dystrophy, and in cases with marked deformity of the spine resulting from caries or other cause. The dwarfism may be confined to one limb or may affect the arm and leg on one side only. The commonest cause of unilateral dwarfism is dyschondroplasia, which may produce gross irregularity in the length of the limbs. In a lad of 18, the affected leg was 10 inches shorter than the other.

TABLE III.

DWARFISM (Distribution).

GENERAL.

    Osteogenesis Imperfecta (excluding severe pre-natal cases).
    Diaphyseal Aclasis.
    Ateleiosis (Sexual).
    Progeria.

SHORT LIMB TYPE.

    Achondroplasia.
    Osteogenesis Imperfecta (severe pre-natal cases).
    Dysplasia Epiphysealis Multiplex.
    Dysplasia Epiphysealis Punctata.
    Cretinism.
    Rickets.
    Cœliac Rickets.
    Renal Rickets.
    Simmonds' Disease.
    Fröhlich's Disease.

SHORT TRUNK TYPE.

    Chondro-Osteo-Dystrophy (Morquio-Brailsford).
    Gargoylism.
    Gross Deformity of the Spine (e.g., caries).

It is important to keep in mind that dwarfism may be present and obvious at birth or may only develop later, in spite of the fact that in both groups of cases the fundamental error was established in 'fœtal life. Achondroplasia and cretinism are examples, respectively, of these two groups.

Lastly, dwarfism may result from conditions acquired after birth.

TABLE IV.

DWARFISM (Time of appearance).

PRESENT AT BIRTH.

    Achondroplasia.
    Osteogenesis Imperfecta (Severe Pre-natal Cases).
    Dysplasia Epiphysealis Punctata.

DEVELOPED AFTER BIRTH.

    Due to Pre-natal Fault.

        Osteogenesis Imperfecta (moderate severity).
        Osteopetrosis.
        Diaphyseal Aclasis.
        Dyschondroplasia.
        Chondro-Osteo-Dystrophy (Morquio-Brailsford).
        Ateleiosis (Sexual).
        Gargoylism.
        Cretinism.

    Due to Fault acquired after Birth.

        Rickets.
        Cœliac Rickets.
        Renal Rickets.
        Ateleiosis (Asexual).
        Progeria.
        Simmonds' Disease.
        Fröhlich's syndrome.

There are two chief types of excessive growth of the skeleton or gigantism, both due to endocrine errors. Hyperpituitary gigantism results from an eosinophil adenoma of the anterior lobe, the secretion becoming excessive during childhood or adolescence, that is while growth is still taking place. If the excess of secretion operates later, after growth has ceased, acromegaly is the result. It is not surprising, therefore, that some of these hyperpituitary giants—more than 40 per cent. of them, it is said—develop signs of acromegaly later.

The other form of gigantism is the eunochoid type due to hypogonadism. The onset is in adolescence ; fusion of the epiphyses is delayed ; genital infantilism is present ; the limbs are long.

Now we might consider, very briefly, the main distinguishing features of some of the affections referred to.

Osteogenesis imperfecta and osteopetrosis deserve more detailed attention and will be dealt with presently.

Diaphyseal Aclasis or multiple exostoses, and *Dyschondroplasia* (Ollier's Disease) or multiple enchondromata are often, quite unnecessarily, confused. It is true they both result from an error on the part of the epiphyseal lines, islands of cartilage becoming misplaced instead of being calcified and replaced by bone in the normal manner, but in diaphyseal aclasis these islands of cartilage are on the surface of the bones and produce the projecting exostoses capped with cartilage, while in dyschondroplasia the masses or columns of cartilage are situated endosteally inside the metaphyses, or less commonly in the shafts, of the long bones. Diaphyseal aclasis is frequently inherited, dyschondroplasia is not. In diaphyseal aclasis, besides the exostoses which tend to have a characteristic shape, there is an irregular enlargement of the metaphysis—at least in all the well-marked cases—which results from a failure on the part of the periosteum to mould the bone during growth in the normal manner : in such cases there is general reduction in the stature. In dyschondroplasia on the other hand the changes show a distinct tendency to be unilateral and only the affected bones are stunted, while they are often deformed in addition. Lastly, enchondromata in the hands are particularly common, and often cause considerable crippling of the fingers, whereas exostoses are few, small and unimportant on the bones of the hands.

There are two conditions, both of them rare, in which the chief changes are found in the *epiphyses*. In the epiphyseal dysplasia, to which I have attached the adjective multiplex, the changes are not unlike those of osteo-chondritis, for which they are usually mistaken. For the punctate group the alternative title of Stippled Epiphyses is amply justified by the appearance of the epiphyses. In this latter group the changes in the skeleton generally are very marked ; bilateral congenital

cataract and contractures of joints are common complications; death from intercurrent disease in infancy is a frequent occurrence.

Chondro-osteo-dystrophy of the *Morquio-Brailsford* type displays wide-spread changes in the skeleton, but the chief features are shallow vertebral bodies with a prolongation or tongue projecting anteriorly, angular kyphosis associated with a reduction in size of one body near the dorsi-lumbar junction, and gross changes in the acetabula and femoral heads which may easily be mistaken for osteochondritis.

The other type of chondro-osteo-dystrophy, *Gargoylism,* is conveniently considered here, though it is now classified with the lipoidoses. Though in this condition a kyphotic curve is often present, associated with one vertebral body reduced in size as in the preceding condition, the bodies are not flattened : two or more in the region of the kyphosis display a characteristic shape, the lower anterior part projecting in the form of a beak. Additional features, some or all of which may be present, are cloudiness of the corneæ, mental deficiency, large head with heavy facies, and enlargement of the liver and spleen. The hips differ strikingly from those seen in the Morquio-Brailsford type, coxa valga and long femoral necks being usually seen in gargoyles. Limitation of movement of some joints may be present in both types, while in the Morquio-Brailsford type laxity of some joints may also be seen, even in one and the same case.

The appearance of *achondroplasiacs* is familiar to all, and I will only call attention to peculiarities of the skeleton. The long bones are relatively short and thick, the ends of the shafts expand more abruptly than usual, and the centres for the epiphyses appear closer to the shafts than in normal bones, so that in the younger children the joint space, as seen in a film, is much wider than usual. The lower end of the femur is notched in the middle, and the epiphysis projects into the notch, while the cortex of the metaphysis may appear to overlap or embrace the epiphysis to some extent. In some cases a vascular fibrous band grows in from the periosteum between the zone of ossifying cartilage, and the rest of the epiphysis : no wonder growth is deficient. In the skull there is premature fusion of the pre- and post-sphenoid and the basi-occipital to form the " os tri-basilare," which is abnormally short and accounts for the typical facies. Harris (1933) maintains the underlying feature is mucoid degeneration of the cartilaginous epiphyses. If this is the whole story, how is it that these dwarfs are so singularly true to type ?

In *Cranio-cleido-dysostosis* the abnormalities are not confined to the vault of the skull and the clavicles, which show varying degrees of imperfect ossification. Only very rarely is the clavicle completely absent (8·1 per cent., Stocks and Barrington, 1925). The pubis, though present, may completely fail to ossify till far beyond the normal time (Crouzon et

Bouttier 1921) and the space at the symphysis may remain permanently wider than normal and somewhat irregular in shape. Coxa vara of the infantile or cervical type, epiphyseal centres at both ends of the metacarpal bones, delayed fusion of the mandible and of the neural arches, and stunted terminal phalanges and short nails are other abnormalities met with in this condition.

Arachnodactyly displays long digits in the hands and feet, and muscular weakness, which seems to be very slowly progressive. Joint movements may be either limited or too free. Congenital dislocation of the lens and trembling irides are quite common, and there may be congenital heart disease.

Osteopoikilosis, or " spotted bones," is a condition in which there are multiple dense spots in the bones. They may be circular but are often oval with the long axis in the line of the bone. They occur principally in the metaphyses and epiphyses, and only rarely nearer the centre of the shaft of a long bone. They are the cause of no symptoms and are always discovered by chance. The skull, ribs and vertebrae are almost invariably free from spots. Males are far more commonly affected than females. Some cases are associated with dermato-fibrosis lenticularis.

Polyostotic fibrous dysplasia is characterised by multiple lesions of a fibro-cystic nature, but without hyperparathyroidism. The fibrosis of the bones may give rise to three types of change in an X-ray film, *viz.*, cyst-like spaces, increased density, which is often in streaks, and general enlargement of a bone shaft with uniform medium density and a very thin cortex. The last is not uncommonly seen in the metacarpals and metatarsals. The changes are inclined to be unilateral in distribution, and may be associated with leontiasis of the skull, the essence of which is also fibrosis.

In *Albright's syndrome* the fibrous dysplasia of the bones, again tending to be unilateral in distribution is associated with areas of pigmentation of the skin, preferably on the same side as the bone lesions, and precocious puberty, particularly, but not quite exclusively, in females.

In the sexual form of *Ateleiosis*, in which are included most of the professional midgets, the sexual organs develop more or less normally while in the asexual type the infantilism is generalised. Of the sexual type the cause is unknown ; the asexual form results from a pituitary error.

Progeria is the name given to a mixture of infantilism and senilism.

Osteogenesis Imperfecta is characterised by fragility of the bones. Fractures may be present at birth (pre-natal type) or the first fracture may not occur till a few years later, even as late as the seventh year (post-natal type). Familial and hereditary influences are in evidence.

Blue sclerotics, rather deep or indigo in colour, are seen in some cases of both types, more commonly when the affection is post-natal in onset or is inherited. Some members of an affected family may show only blue sclerotics, some only fragility, some both these signs, and yet others are completely normal. Otosclerosis may attack those who live long enough—usually not till the third decade—and again more commonly in the inherited cases and in those with blue sclerotics. The temporary teeth are poorly calcified and yellowish. The permanent teeth are always better than the temporary. In some cases, particularly the severe ones, the bones show a tendency to bend (mollities) as well as break: the pelvis becomes indented.

Fractures may vary in number: many, but not all, of the severe pre-natal cases die at birth, with many fractures, notably of the ribs. Repeated fractures of one bone are not uncommon: no doubt the immobilization necessitated by the first fracture leads to further decalcification and increased fragility, a point worth keeping in mind. The skull is usually broad and bulges over the ears, which are tilted somewhat downwards. Sometimes the occiput forms a pointed projection.

There is a tendency to gradual improvement in all but the most severe cases, but occasionally even in them.

Pathologically there is poor formation of trabeculæ, and islands of cartilage are seen, notably under the periosteum which fails to form a normal continuous shell of cortical bone. The number of osteoblasts varies: the condition cannot be attributed to a scarcity of these cells, which in some cases are plentiful.

Radiologically there are three types :—

1. Thick-boned type. Pre-natal. The femora, tibiæ and humeri are thickened, and this is not obviously due entirely to callus formation. These are the cases which display dwarfism of the short-limb type. In three months or so, in cases which survive, the bones become similar to those in class 2.

2. Slender, fragile bone type, seen in pre-natal cases that survive, and in post-natal cases. The bones are delicate, and the cortices, thin and of diminished density. Fractures, recent and old, and resulting deformities. are common. The skull is thin : Wormian bones are common. The vertebral bodies are usually shallow, biconcave and osteoporotic.

3. Cystic type. This is very rare.

Osteopetrosis : Albers Schönberg's Disease. This is characterised by increased density to X-ray of the skeleton generally. It is occasionally hereditary : more often familial. With the density of the bones are associated anæmia and optic atrophy. The course of the disease may be malignant or benign. The aplastic anæmia resulting from reduction of

the bone marrow is a source of real anxiety. There may be intermissions, remissions or complete cessation of the dense bone formation as seen in radiographs. Calcinosis in the soft tissues may be present occasionally. Hydrocephalus may occur, and other cranial nerves besides the optic may be affected. The base of the skull shows a particular degree of density. Dwarfism may be present. In the radiographs, the bones may be completely dense and structureless. In other cases the increased density is seen only in the metaphyses which are enlarged and clubbed. Alternating transverse bands of more dense and less dense bone may be seen, or the tendency to form dense bone may cease completely, the new bone added to the ends of the shafts being of normal or, perhaps more frequently, of subnormal density. Faint longitudinal striation may be seen. The hands show less intense changes than the rest of the skeleton : in a mild case the transverse bands of increased density may suggest those seen in poisoning by phosphorus, bismuth and lead. Pathologically the change is one of sclerosis. There is more bone, not hypercalcified bone. There may also be some calcified cartilage, which adds to the density. Fibrosis of the marrow may be present, and it is suggested the anæmia may depend more on this than on the degree of the reduction of the marrow space. The bones may be completely solid, as seen in this femur, which belonged to an old lady who somehow managed to live to 75, with no anæmia and no optic atrophy in spite of severe generalized osteopetrosis.

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THE RESTORATION AND DEVELOPMENT FUND

BILIARY PASSAGES

Subject of an Erasmus Wilson Demonstration at The Royal College of Surgeons of England
on
1st March, 1948
by
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Surgeon, Royal Northern Hospital and Metropolitan Hospital

GALLSTONES ARE OF different varieties—calcium carbonate, cholesterol, pigment calculi and the common variety, composed mainly of cholesterol and bile salts. These latter may number from one single stone to many thousands, and I believe the greatest recorded number was reported by Shanker, who removed a gall bladder containing 36,329 calculi.

Symptoms may be negligible or even non-existent, but usually the patient complains of flatulent dyspepsia. Suspicious cases should be submitted to a straight X-ray, which confirms the diagnosis in 30 per cent. of cases, or, if this is negative, by means of a cholecystogram. A positive diagnosis depends on four factors—absorption of the dye, excretion by the liver, patency of the cystic duct, and a gall bladder which is not completely contracted or entirely filled by a large calculus. A negative cholecystogram does not exclude gall stones, for small calculi may be present which cause no shadow or filling defect in the gall bladder.

When gallstones are discovered removal is imperative, even if they give rise to only trivial symptoms, owing to the constant risk of serious complications.

Space forbids a description of all the possible complications, but some of the more important are as follows :—

Acute cholecystitis—which may be difficult to distinguish from acute appendicitis. In doubtful cases an area of cutaneous hyperæsthesia is sometimes diagnostic. If the appendix is acutely inflamed and distended hyperæsthesia will be present over the appendix area, but, in the case of a distended gall bladder, the hyperæsthesia will be found below the angle of the right scapula (Boas' sign).

Unanimity of opinion in the treatment of acute cholecystitis is gradually developing. Even 20 years ago expectant measures were usually adopted, and results were better than in cases treated by emergency operations. Since those days sulphonamide and penicillin are available to overcome infection, a Ryle's tube assists in combating vomiting, and an intravenous infusion sustains the fluid balance and counteracts chloride depletion. It must be remembered that acute cholecystitis occasionally occurs in young children, and if this diagnosis cannot be

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refuted emergency operation is indicated (as it is in any stage of acute appendicitis during the first decade).

Obstruction of the common bile duct is often a serious complication, especially if liver function is deficient. Cholæmia is apt to result, just as uræmia may follow urinary obstruction when the kidneys are damaged. Following an attack of colic, jaundice supervenes. The jaundice is typically intermittent, owing to the ebb and flow of œdema in the wall of the duct at the site of impaction of the stone. As the gall bladder is probably fibrotic as a result of long-standing infection, no clinical evidence of enlargement is to be expected.

The patient must be kept in- bed under observation in the hope that the stone will continue its journey into the duodenum. Pethidine, 25-50 mgm. three times a day, is prescribed in order to overcome spasm of the bile duct and of the sphincter of Oddi. Glucose, urotropine and sulphonamide may have their uses. Unless the obstruction is overcome surgical intervention is required before hepatic failure is imminent. Vitamin K is prescribed to counteract excessive bleeding, and if the condition of the patient is precarious cholecystostomy is performed, in order to relieve back pressure on the liver by the minimum surgical procedure. All being well, the stone is removed a few weeks later, in addition the common duct is drained and cholecystectomy performed, either then or at a later date.

In three patients who were poor surgical risks I performed cholecysto-duodenostomy as the simplest procedure for relief of obstruction to the common duct due to a calculus. They all made good recoveries, and were apparently none the worse for the continued presence of the impacted stone.

Fistula formation is less common than in the pre-cholecystogram days, as gallstones are usually discovered by radiography and so receive appropriate surgical treatment. Gallstones, in addition to escaping through an external fistula at the umbilicus, have been passed by all the natural passages. From the surgical aspect the most important fistula is that between the neck of the gall bladder and the duodenum. If the extruded gallstone is over one inch in diameter small gut obstruction will occur, usually about two feet above the ileo-cæcal valve. This type of intestinal obstruction occurs in elderly patients of 70 or 80 years of age, or even older. Females are affected ten times as commonly as males. The explanation of the ripe age of these patients is that two slow processes are involved : firstly, the formation of a stone large enough to cause obstruction, and secondly, the gradual erosion of the gall bladder and formation of a fistula. Each of these processes probably take many years. The mortality of gallstone obstruction is about 30 per cent. Various reasons combine to render this complication dangerous, such as age and delay in diagnosis ; also of the four cardinal features of acute

intestinal obstruction—pain, vomiting, distension and absolute constipation, only vomiting occurs in the early stages. Pain is slight as there is no acute kink or torsion of the bowel, distension is not excessive until late, and absolute constipation is absent as small quantities of chyme seep past the stone, and thus even repeated enemata produce some slight fæcal result. It is a golden rule that an elderly patient who persistently vomits for more than six hours for no apparent reason should be suspected as a possible victim of gallstone obstruction. In a thin person the stone may be palpable in the right iliac region, and cases are recorded where the stone has been discovered on vaginal examination. Removal is a simple matter, and it is usually easy to manipulate the stone proximally so that the incision is made through comparatively healthy bowel.

Carcinoma of the gall bladder is almost unknown in the absence of calculi, and owing to metaplasia consequent on chronic irritation, the growth is usually spheroidal-celled. The disease is of the " silent variety " and thus resembles carcinoma of an ovary or one situated in the body of the stomach, as in these three situations symptoms are often absent or slight until the primary lesion is extensive or widespread dissemination occurred. In the case of the gall bladder epigastric discomfort or the discovery of the swelling may impel the patient to seek advice. A hard and irregular swelling is usually palpable in the gall bladder region, and in the absence of obvious metastases or ascites a laparotomy should be performed. In some five per cent. of cases the growth may be sufficiently localised to permit of diathermy resection with an adjacent wedge of liver, but recurrence deeper in the liver is the rule.

Treatment of Gallstones.

Cholecystectomy

It is true that gallstones may remain " silent " for many years, and they are occasionally discovered accidentally when an X-ray is taken for some other purpose, e.g. to ascertain if a rib is fractured. Nevertheless, even in these cases cholecystectomy is desirable, as dangerous complications may suddenly overtake the patient, or, as in the case of carcinoma or fistula formation, develop insidiously. Therefore, unless there is some severe constitutional disease or threatened mental instability, operation should be urged. If the patient is obese three months may well be spent in weight reduction.

Anæsthetic.—Until recently high spinal anæsthesia provided the most adequate relaxation, but with the introduction of curare a general anæsthetic is admirable, and excludes those infrequent but unfortunate complications associated with a spinal anæsthetic, such as nerve palsies or bladder derangements.

Position of the patient.—Some experienced surgeons consider that the use of a bridge and consequent arching of the back not only causes post-operative discomfort, but also hinders the return of blood along the inferior vena cava and so predisposes to distal thrombosis. In thin patients; especially if some degree of hepatosis is present, the use of a bridge is unnecessary. However, in difficult cases the improved exposure obtained by the use of the bridge outweighs its possible disadvantages. A more important predisposing cause of pulmonary embolism is failure to support the heels during the operation. It is now recognised that thrombosis originates in the veins of the calf or even of the feet, and if these veins are compressed by the weight of the leg, both local and distal venous circulation is retarded, and the likelihood of thrombosis is encouraged. The placing of a sandbag or sorbo rubber support under the heels should be a routine procedure when an adult patient is placed in position for any abdominal operation.

Dissection begins at the neck of the gall bladder, and when the three biliary ducts are exposed the cystic duct is divided one-quarter of an inch from its junction with the common duct, and ligated with thread or fine silk. If the cystic artery has not already been visualised it will come into view and be ligated when the neck of the gall bladder is separated from the liver bed. Using a diathermy knife, the peritonium covering the gall bladder is incised so as to leave a fringe on either side (Fig. 1). Gentle traction at the neck of the gall bladder facilitates diathermy dissection of the organ from its bed. An account of abnormal ducts is outside the scope of this article, but one duct should now be mentioned as it is easily overlooked. This is the cholecysto-hepatic duct, which is about 2 mm. in diameter, and which runs directly from the liver into the gall bladder (Fig. 2). As the gall bladder is dissected from its bed a careful watch must be kept for this thread-like structure, and if recognised it is ligated. Accidental division of the duct should be suspected if a small trickle of bile repeatedly appears at one spot in the gall bladder bed. In such a case ligation is difficult, so the adjacent liver is coagulated by means of diathermy. In this circumstance it is prudent to drain the abdomen in case bile subsequently leaks from the divided duct. If the duct is overlooked a biliary fistula will result, which usually closes spontaneously within a few weeks, but meanwhile causes concern to the surgeon and distress to the patient. Unless the surgeon is familiar with the possibility of injury to the cholecysto-hepatic duct " slipping " of the ligature on the cystic duct is usually advanced as an explanation of the fistula.

The gall bladder is removed in stages, and at each pause one or two bites of a continuous suture are inserted so as to cover the exposed bed (Fig. 3).
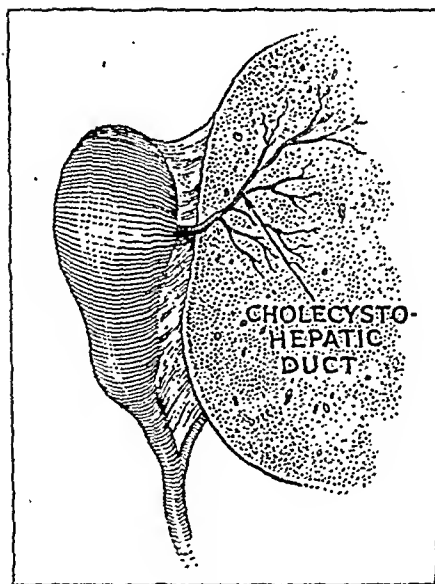
FIGURE 3.

The appendix is usually removed and the wound is closed *without drainage.*

Partial Cholecystectomy.—This operation consists in emptying the gall bladder, excising the bulk of the organ with scissors, and coagulating the remaining portion so as to destroy the mucosa. This procedure is occasionally useful if the gall bladder is difficult of access, and especially if the organ tends to be buried in the liver.

Cholecystostomy.—Drainage of the gall bladder with removal of stones still has a place in biliary surgery. A gall bladder which is contracted and buried in adhesions, especially if the patient is fat or frail, is wisely treated by removal of calculi, curetting the mucosa and drainage of the viscus.

Mortality.—In skilled hands the average mortality of the standard cholecystectomy with drainage is about 2 per cent., the two commonest causes of post-operative death being chest complications and pulmonary embolism. Both these conditions are encouraged by limited movements of the diaphragm. In the standard cholecystectomy drainage is usually necessary, and a puddle of bile and blood collects beneath and irritates the diaphragm, also respiratory excursions are further hampered by the presence of the drainage tube.

If diathermy dissection is performed irritation of the diaphragm is minimal, and the patient can breathe deeply as soon as consciousness returns. Convalescence usually proceeds smoothly, and minor, but tiresome chest complications, are uncommon. In addition, the patient
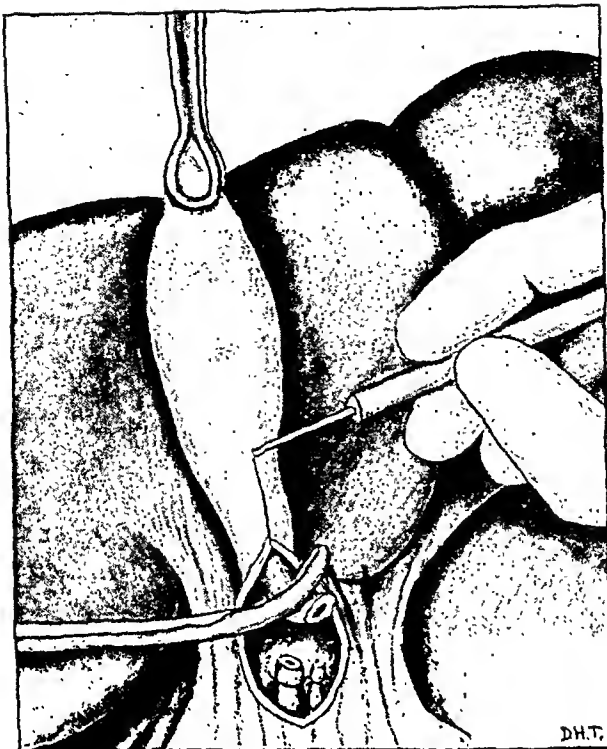
Fig. 1

The peritoneum over the gall bladder is incised with a diathermy knife.
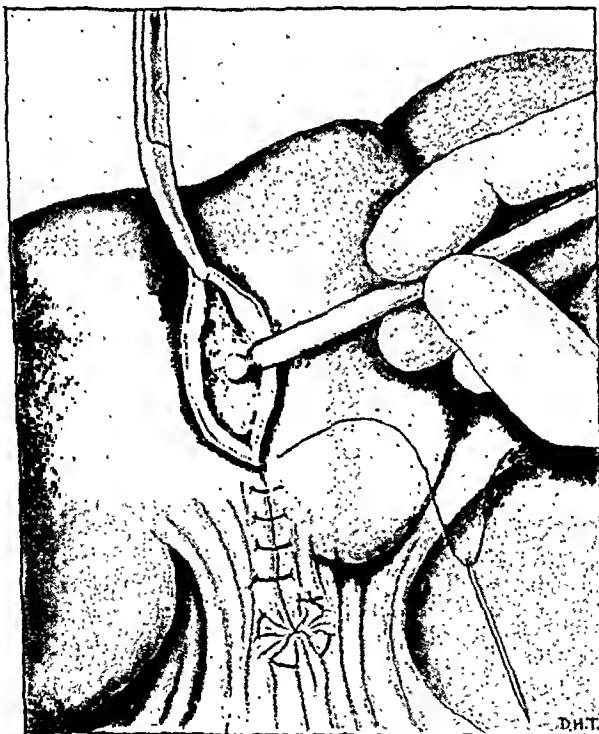
Fig. 2.

Coagulation of the gall bladder bed with a diathermy button.

Fig. 4

Normal cholangiogiam—no distortion of the common bile duct, and lipiodol flows freely into the duodenum.

Fig. 5.

Filling defect in the common duct due to a stone. Gross dilatation of all the bile ducts, and spasm of the sphincter prevents lipiodol from entering the duodenum.

Fig. 6.

Moderate obstruction of the common duct due to chronic pancreatitis, but lipiodol enters the duodenum freely.

Fig. 7.

Carcinoma of the pancreas resulting in gross dilatation of the common duct, with abrupt and complete obstruction at the lower end.

is spared the disturbance of the periodical removal of bile-soaked dressings with a consequent saving of time and energy of the nursing staff. If diathermy dissection and closure of the abdomen is employed the mortality of cholecystectomy is reduced from 2 per cent. to about 0·5 per cent.

Exploration of the Common Bile Duct

The surgeon is not uncommonly faced with the problem as to the advisability of exploring the common bile duct or not. The usual indications for exploration is as follows :—

(i) The presence of a palpable calculus.

(ii) Obstruction or constriction of the duct by a neoplasm in its wall.

(iii) Obvious dilatation of the duct.

(iv) Recent jaundice if presumed to be due to the passage of calculi.

Some of these conditions are obvious when the duct is visualised and palpated at operation, but it may be difficult to distinguish between a calculus and a lymph node. Also in some cases a calculus is present in the duct without causing obvious obstruction, or hindering the passage into the duodenum of a malleable probe. Again, the duct may be patent although obviously distended.

In such cases a cholangiogram provides valuable information, and should be performed in all but the simplest cases.

Technique.—If it is decided that a cholangiogram is advisable, traction is applied to the neck of the gall bladder so as to render the cystic duct taut. The duct is nicked with sharp-pointed scissors about half-an-inch from its junction with the hepatic duct. Then lipiodol or neohydriol is injected into the common duct by means of a malleable cannula, or if this is not available, some three inches of a ureteric catheter, attached to a syringe is a suitable substitute. When the cannula is securely in the lumen of the cystic duct any instrument which would obscure the field is removed and 5-10 ml. of fluid is injected during a period of five seconds. The exposure is made as the last of the fluid is injected, and the film is ready for inspection in about five minutes, during which interval the surgeon can be usefully employed in removing the appendix or in continuing the exposure and dissection of the biliary ducts. If the cholangiogram indicates that it is wise to explore the biliary passages the slit in the cystic duct is extended into the common duct so that suitable instrumentation can be performed. · If advisable the duct is subsequently drained by means of a T-shaped tube, and cholecystectomy is then performed by diathermy dissection.

A cholangiogram often provides valuable information regarding the state of the ducts. On the one hand unnecessary exploration may be avoided, or, conversely, the information derived may prevent the surgeon

from overlooking some condition in which exploration or other operative procedures are advisable.

ILLUSTRATIVE CASES

If the biliary apparatus is normal lipiodol flows freely into the duodenum and a clear picture is obtained of a duct of normal calibre (Fig. 4). Pathological conditions which affect any tube arise either outside the wall, in the wall, or in the lumen. In the case of the common duct a cholangiogram not infrequently provides useful information regarding distortion or distension, which cannot be obtained by mere inspection and palpation.

Case I.—Female, age 51, biliary symptoms many years, and colic and jaundice for three months. A simple X-ray revealed multiple gallstones. At operation the common duct was dilated, but nothing abnormal was discovered on palpation. A cholangiogram revealed a filling defect due to a stone in the lower end of the duct with spasm of the sphincter (Fig. 5). The stone was withdrawn and the sphincter dilated.

Case II.—Female, age 68, over 20 years dyspepsia. X-ray showed a poorly filling gall bladder. At operation the gall bladder was adherent and fibrotic, but no stones were present. The cholangiogram revealed a common duct about three times the normal size, somewhat constricted at the lower end, but lipiodol flowed freely into the duodenum (Fig. 6). The cholangiogram indicated the presence of subacute pancreatitis, with associated compression of the duct. Simple diathermy dissection was performed, and, aided by an occasional course of a pancreatitic preparation, the patient has remained in good health for the past three years.

Case III.—A male, age 63, presented himself with abdominal discomfort and variable jaundice of three months' duration. Short attacks of pain occurred at irregular intervals. The cholecystogram was inconclusive, and gallstones were suspected. At laparotomy the gall bladder was moderately enlarged and the common duct was grossly distended. The head of the pancreas felt somewhat nodular, but the altered consistency was not sufficiently definite to warrant a confident diagnosis of carcinoma. However, the cholangiogram revealed the abrupt occlusion of the common duct, so typical of neoplasm of the head of the pancreas (Fig. 7). Fortified by this evidence, a successful pancreato-duodenectomy was performed, a procedure which one would have hesitated to perform without the confirmation afforded by the cholangiogram.

Cholangiography is a simple procedure, and after over five years' experience the author reflects that on numerous occasions it has been of great assistance in deciding the wisest procedure to adopt in problematical or difficult cases. It appears that this is a method of investigation which might well be more universally adopted.

8. THE FELLOWS' CUPS

The Monthly College Dinners

MONTHLY DINNERS on the Wednesdays before Council Day have now been held regularly at the College for over two years, and have been greatly appreciated and well attended. Members of Specialist Associations attached to the College and graduate students attending courses of instruction are eligible to attend, as well as Fellows, Members and Licentiates of the College. Guests are permitted, and the dinners have provided convenient opportunities for entertaining distinguished visitors from the Dominions and other countries besides personal guests. In fact subscription dinners are by no means an entirely new development but rather a revival of a Collegiate amenity initiated by the Fellows of the College over 100 years ago.

The Fellowship of the College was instituted in 1843 by Royal Charter granted by Queen Victoria in the seventh year of her reign. Authority was given to elect a body of Fellows from among the Members, their number to be not less than 250 or more than 300. The main nominations were to be made within three months, with a limit of one year before the list was closed.

Fellows soon developed a Collegiate spirit, and showed a desire to get together by founding an Annual Subscription Dinner, which was held regularly from 1846 to 1888.

Some interesting details can be culled from the Minutes of the Committee and Records of the Dinners. The hour of dining, for example, changed gradually through the years. Originally dinners were held at 5.30 p.m., but gradually got later, passing to 6, then 6.30, 6.45, and finally 7 o'clock.

Another interesting example of change is in the menus since the 1880's. With the systematic shrinkage to which British stomachs have been subjected since 1939, quite apart from the change of habits, it is doubtful whether any diners to-day could do justice to a menu such as our predecessors dealt with in the old days of the Fellows' Dinners. Capacity, apart from inclination, would prevent the consumption of such banquets as were served to them.

The dinners were held outside the College—first at Freemasons' Tavern (15 years), then at the Albion Tavern, Aldersgate Street (25 years) from 1862-1886, and then for two years, 1887 and 1888, at the Holborn Restaurant.

Throughout the records it is clear that the dinners were well attended, the numbers varying from 65 to 140 and averaging about 100. There

were certain official guests, and the Chairman, who was elected for each occasion was allowed to invite others.

After 1888 there is a nine-year lapse in the records, and presumably in the holding of the dinners—no explanation appearing in the Minutes. The next and last Fellows' Dinner outside the College of which there is record was held in 1897 at Limmer's Hotel, George Street, Hanover Square. Ninety-seven were present on that occasion, and Mr. Thomas Bryant was in the Chair.

The next record is to be found in the Minutes of the Council for December, 1903 (seven years later) when the recommendation of a Committee that the suggestion of the President (John Tweedy) that there should be a Fellows' Subscription Dinner at the College on the day of the Council Election was agreed to. The first dinner was held in the Library on July 7th, 1904, and 100 were present. It was held again in 1905, when 89 were present and a loving cup was presented to the College by Thomas Bryant as a gift from the survivors of the permanent Committee. The Committee of Fellows had already presented a cup to the College in 1893 on the occasion of the Jubilee of the Fellowship, Thomas Bryant, President, and John Whitaker Hülke, his successor in the Chair, being the moving spirits in the presentation.

The " Fellows' Dinner " Cup.　　　　The " Fellowship Jubilee " Cup.

While Tweedy was still President a dinner was held in 1906, 65 being present, but when Henry Morris became President they were discontinued. It is recorded in the Council Minutes in 1907, 1908 and 1909

that resolutions were passed deciding "that a Fellows' Dinner be not held this year," after which there is no further mention of them until 36 years later, when, on April 12th, 1945, the Council decided to institute the present monthly dinners with wider eligibility.

The Minutes of the last meeting of the permanent Committee of the Fellows' Dinner are as follows :—

"At a meeting held at 42, Norfolk Square, W., on June 19th, 1905, the Permanent Committee (appointed February 25th, 1880, and consisting of the present and last Chairmen, and the present and last two Secretaries) the following attended :—

Mr. Thomas Bryant as last Chairman.

Mr. Woodhouse Braine as Past Secretary.

Mr. C. Carter Braine as Present Secretary.

A letter was read from Mr. Benjamin Lowne, past Secretary, regretting his inability to attend the meeting.

The Secretary reported that after paying all past debts there remained a balance of £78 15s. 8d. in Parr's Bank, Hanover Square.

The question of the continuation of the original Fellows' Dinner was carefully considered, and the following conclusions were arrived at :—

(1) The adoption of a Fellows' Dinner at the Royal College of Surgeons in 1904 renders it unnecessary to continue the practice of holding this dinner as formerly.

(2) After careful consideration it was decided that a " loving cup " as a memorial of this dinner be presented to the Royal College of Surgeons of England, together with the book containing the minutes of the past meetings ; and that the balance be presented in the name of the Permanent Committee to Epsom College."   W.-J.

SAYINGS OF THE GREAT

" Thy friend hath a friend, and thy friend's friend a friend—Be discreet."—*Pope*.

" Without appreciation of language clearness of thought is impossible, and literary form is one of the best guarantees of good reasoning." . . . " Even a scientific article could and should be beautiful in its fitness of expression, and it will not lose in its usefulness if it pleases the ear as well as satisfies the reason."—*Starling*.

" It is an old story that the reception of new ideas tends always to be grudging and hostile."—*Trotter*.

" There's great hope for a shaky hand, but none for a shaky mind." —*Sir William Macewen* (contributed by W. J. Moore, F.R.F.P.S.).

Note.—Contributions are invited.

FELLOWS' DINNER

MENU (1888)

Hors-d'œuvres

Anchovy Salad   Sardines

Canapé de Caviare   Lyons Sausage

Chablis

Soups

Thick and Clear Turtle

Madeira

Fish

Salmon and Lobster Sauce

Whitebait

Hock Rudesheimer

Entrées

Quail Cutlets in cases   ·   Sweetbreads à la Portuguese

Champagne—Louis Roederer's Carte Blanche 1880 vintage

Punch à la Romaine

Removes

Roast Lamb and Mint Sauce

Grilled Ham and Peas

Mayonnaise of Lobster

Roast

Ducklings and Watercress   Peas

Sweets

Apricot Meringues   Charlotte à la Russe

Chartreuse of Strawberries

Ice Pudding

Liqueurs

Cheese   Salad

Dessert

Port   Claret

Café Noir et Cognac

THE FIRST ILLUSTRATED ANATOMY :

KETHAM'S FASCICULUS MEDICINÆ

THE SLIM, LARGE-PAGED *Fasciculus Medicinæ*, with its half-score of full-page illustrations, is the most interesting and beautiful of the anatomy books produced between the invention of printing in the mid-fifteenth century and the publication of the unsurpassed *Fabrica* of Vesalius in the middle of the sixteenth (1543 ; revised edition, 1555). The *Fasciculus* is essentially a book of the middle ages, though showing in the style of its drawings the influence of the renaissance escape from fixed acceptance of tradition to the direct observation of nature ; the matter of both text and drawings is purely traditional. The Latin text first published at Venice on July 26, 1491, is a compilation of various older medical guides, which were in daily use by the practising physician or surgeon, put together over the name of Johannes de Ketham. Sudhoff and Singer, who made a thorough study of the book and its sources 24 years ago, identify this supposed author with Hans Kelner von Kircheim, lecturer in medicine and surgery at Vienna 20 or 30 years before the book was published. Master Hans was renowned for his interest in practice rather than theory, and had probably used and recommended to his pupils just such brief compendia of rules for uroscopy —that is, prognosis from the urine—venesection or blood-letting, obstetrics, the practical handling of wounds, and the treatment of common ailments. Certainly these texts and the diagrams which they explain were widely circulated in manuscript from at least the beginning of the fifteenth century, nearly a century before the publication of our book : Sudhoff has traced their derivation far back through the middle ages. To this brief collection with its six large woodcuts, all now appearing for the first time in print, the publishers added a separate tract on the avoidance of the plague by Pietro da Tussignano, also a medieval production, which had been printed before.

The early printers were in general not concerned with the encouragement or exploitation of contemporary authors, but sought to make profit from the diffusion of books already familiar but hard to come by in manuscript form. The brothers dei Gregoriis, publishers chiefly of legal books, who fathered their collection of medical guides on the renowned teacher, ' Johannes de Ketham '—as they corrupted Kircheim's name—were thus not really innovators, although their book is the first printed medical work to contain a series of didactic woodcuts, a picture-book, in fact, with descriptive text. Sudhoff showed by a comparison of manuscripts from many European libraries, such as he alone had the learning to make, that the printed *Fasciculus* of 1491 looks back to much earlier manuscripts, and was a reversion rather than an advance

in form. But the publishers gauged their public well, and the book " found a good market, perhaps because there was nothing new in it."

The demand for it was evidently keen, as the book went through several editions, each of which has its variations from the first. An Italian translation was issued by the Gregoriis in 1493, of which more will be said below. On the basis of this version the Latin *Fasciculus* was revised and republished in October, 1495, and in February, and again in March, 1500, all from the press of the Gregoriis. There was also a Spanish translation, and further issues of both the Latin and the Italian versions.

The College received a copy of the Latin 1495 edition from the library of Sir Anthony Carlisle, President in 1828 and 1837, to whom it owes very many of its early printed books ; and it has long possessed the edition of 1522 printed by Cesare Arrivabeni. This year an opportunity has been taken of acquiring a fine copy of the Gregoriis edition of 1513, which has not appeared in the London book auctions for 50 years.

The illustrations which give its character to the book, divide into two groups, the six practical diagrams which the first edition comprised and the four magnificent scenes of Venetian life which were added in the Italian version of 1493 and repeated with minor variations and changes of sequence in the subsequent editions. These four majestic pictures are lightened by little touches of naive naturalism. They exhibit four episodes of medical practice in the setting and garb of contemporary Venice. Like the six original pictures, all are outline woodcuts without shading, each occupying the full space of a page. First we see the physician and his patients, he sits above at his desk with his books—Pliny, Isaac, Abenzoar and the Conciliator (classical, Arabic, and medieval texts)— around him, while below sit a man with a stick and an old woman with her rosary, besides whom stands a boy with a basket, the man and the old woman have put their baskets on the ground ; the first *Fasciculus* contained sections on the diseases of men and of women, a section on children's diseases was added in the later editions. Secondly, there is a consultation of physicians, this illustrates graphically the prognosis from urines, which forms the first section of the *Fasciculus*, and in the original is represented only by the wheel of 21 urine-glasses, each with its description, which derives from a medieval diagram. This scene shows five venerable figures in long robes and round hats who are approached by a young man and a boy, each carrying urine-glasses ; all stand before an arcade, while a man looks down on them from one of two open windows.

In the third picture, the sickroom, the physician holds a sponge to his own nose and mouth, while he feels the patient's pulse ; on each side of him stands a youth with a lighted torch, the one on the right also carries a basket. The patient, naked to the waist, lies in his bed on a dais ; three women, one with a bowl, attend him. The cat, sitting in the fore-
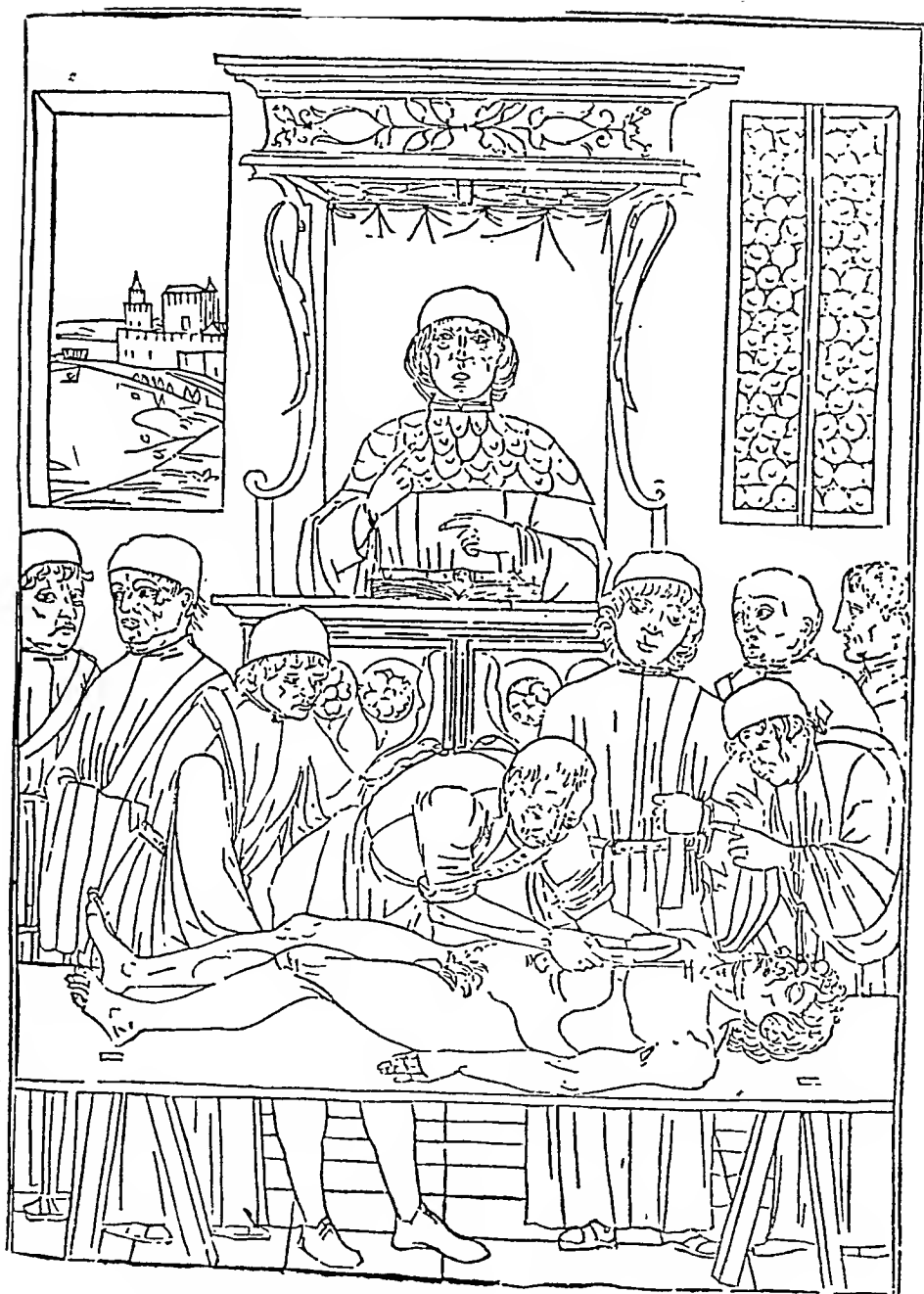
KETHAM'S FASCICULUS : THE ANATOMY LECTURE

ground, is omitted from the later states of the woodcut. This picture illustrates the pest-tract appended to the *Fasciculus* proper. The final picture, reproduced here, represents the most important of the additions in the revised *Fasciculus*, the ' Anatomy ' or dissection-guide of Mondino. Here, the professor sits in his cathedra, while a demonstrator points out the organs as they are exposed by the dissector. Six standing figures look on. This typically medieval grouping is contrary to the spirit of Mondino, whose great merit was that he did his own dissection, just as Vesalius in his title-page group is shown dissecting with his own hands. .

The series of the six original plates is wholly medieval. Besides the urine-glass wheel, there is a ' blood-letting man,' a human figure marked with the sites apt for bleeding for various ailments. In the earlier versions the figure has the names of the signs of the zodiac written across it ; this astrologic indication is more dramatically shown on the following ' zodiac-man,' a purely traditionary conception, where a straddling figure is covered from the Ram at his head to the Fishes at his feet with the formal emblems of the months, with contra-indication of treatment for the parts under their influence. Two other male figures are the ' wound-man,' whose body is marked by daggers, knives and thorns, &c., with the appropriate sites for ligation of arteries in the various injuries, and the ' disease-man,' where the local diseases from Squinantia in the throat to Podagra in the feet are supplemented by lists of more general ills.

The last picture is a gravida. In the first version the traditional seated figure shows a quite unreal diagram of the female viscera, with a formal foetus in utero. But the later versions, while keeping to the same general design, exhibit, as Singer has pointed out, the earliest printed picture of the details really observable at dissection. This version shows the kidneys *in situ* and the non-pregnant uterus, with the portio vaginalis which was wholly omitted from the earlier woodcut. It appears to have been directly influenced by the dissections and the drawings of Leonardo da Vinci.

———————

This account is based on the studies of Ketham and its sources made by Ludwig Choulant, Karl Sudhoff, and Charles Singer.

MONTHLY DINNERS

Monthly dinners held in the College will be resumed in October. The following are entitled to attend with their guests. All Diplomates and students of the College, and Members of the Associations linked to the College through the Joint Secretariat. It is not necessarily intended that guests should be members of the medical profession.

The dinners will be at 7 p.m. on the following Wednesdays :—13th October, 10th November, and 8th December, 1948. There is an inclusive charge of £1 5s. 0d. (including drinks), which must be sent with the application to the Assistant Secretary at least a week before the date of the dinner. The dress is Lounge Suit or Uniform.

FORTHCOMING LECTURES AND COURSES OF LECTURES FOR 1948

11th November, at 5 p.m. .. .. Bradshaw Lecture,
by Mr. L. E. C. Norbury

17th November, at 5 p.m. .. · .. Vicary Lecture,
by Mr. Geoffrey Keynes

23rd November, at 3.45 p.m. .. Imperial Cancer Research Fund Lecture,
by Dr. Cuthbert Dukes

9th December, at 5 p.m. .. .. Robert Jones Lecture,
by Sir Reginald Watson-Jones

Courses

ANÆSTHESIA

October .. .. 45 lectures

SURGERY

October .. .. 12 lectures

ANATOMY, APPLIED PHYSIOLOGY AND PATHOLOGY

October, November and December .. .. 72 lectures

PRACTICAL DEMONSTRATIONS
ANATOMY, APPLIED PHYSIOLOGY AND PATHOLOGY

October, November and December

FACULTY OF DENTAL SURGERY

LECTURE-DEMONSTRATIONS
ANATOMY, APPLIED PHYSIOLOGY AND PATHOLOGY
IN THEIR APPLICATION TO DENTAL SURGERY

September

GENERAL, ORAL AND DENTAL SURGERY

September .. .. 36 lectures

DIARY FOR SEPTEMBER

The College is closed during August.

Mon.	6	5.00	SIR HARRY PLATT—Fractures.
		6.15	MR. A. L. D'ABREU—Diseases of the Tongue.
Tues.	7	6.15	MR. A. D. MARSTON—General Anæsthesia.
Wed.	8	5.00	DR. E. W. FISH—Parodontal Disease.
		6.15	PROF. R. V. BRADLAW—Diseases of the Oral Mucosa.
Thur.	9		L.D.S. Examination (The Properties of Dental Mechanics) begins.
			Pre-Medical Examination begins.
		5.00	SIR STANFORD CADE—Malignant Tumours of the Mouth.
		6.15	DR. J. F. BROMLEY—Radium and Deep X-Ray Therapy.
Fri.	10	6.15	BRIGADIER R. A. BRODERICK—Ulcers of the Mouth.
Mon.	13		L.D.S. Examination (Dental Mechanics) begins.
		5.00	PROF. W. E. HERBERT—Treatment of the Exposed Vital Pulp.
		6.15	DR. P. H. JAUES—Fractures of the Middle Third of the Face.
Tues.	14	5.00	MR. A. C. KANAAR—Hunterian Lecture—Pulmonary Atelectasis.*
		5.00	MR. H. L. HARDWICK—Gingivitis.
		6.15	MR. E. A. CROOK—Surgical Diagnosis.
Wed.	15	5.00	PROF. B. RIENHOFF—Moynihan Lecture—Present Status and Treatment of Malignant Tumours of the Lung.*
		5.00	MR. W. KELSEY FRY—Late Complications following Fractures of the Jaws.*
		6.15	MR. A. C. MCLEOD—Restoration following Fractures.
Thur.	16		First Membership Examination begins.
		5.00	PROF. F. H. BENTLEY—Cleft Palate.
Fri.	17		D. C. H. Examination begins.
		5.00	MR. R. C. BROCK—Lung Diseases in Relation to Dental Operations.
		6.15	MR. S. A. RIDDETT—Complications following Extractions.
Mon.	20	5.00	DR. HEDWIG KUHN—Eye Problems in Industry.*
		5.00	MR. L. E. C. NORBURY—Post-operative Treatment.
		6.15	DR. R. WEAVER—Fluorosis.
Tues.	21	5.00	MR. C. BOWDLER HENRY—Alveolectomy and Osteotomy.
		6.15	MR. G. PARFITT—Preventive Measures—Research and Practical Aspects.
Wed.	22	5.00	SIR CECIL WAKELEY—Surgery of the Salivary Glands.
Thur.	23	5.00	MR. T. G. WARD—Surgical Extractions.
		6.15	MR. H. T. ROPER-HALL—Therapeutics in Dental Surgery.
Fri.	24	5.00	PROF. F. C. WILKINSON—Replantation of Teeth.
		6.15	MR. D. W. C. NORTHFIELD—Head Injuries.
Mon.	27	5.00	MR. P. H. MITCHINER—Treatment of Wounds.
		6.15	DR. S. BEHRMAN—Facial Neuralgias.
Tues.	28		Final Membership Examination begins.
		5.00	MR. RAINSFORD MOWLEM—Osteomyelitis of the Mandible.
		6.15	PROF. M. A. RUSHTON—Dental Caries (Part I).
Wed.	29	5.00	MR. S. ROSS—The Pulpless Tooth and Apicectomy.
		6.15	PROF. H. H. STONES—Oral Tumours.
Thur.	30	5.00	MR. V. E. NEGUS—Diseases of the Maxillary Antrum.
		6.15	MR. C. L. ENDICOTT—Etiology and Diagnosis of Malocclusion.

* Not part of courses.

STRICTURES OF THE COMMON DUCT

by

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FOR YEARS STRICTURES of the common duct have presented a challenge to the science and skill of surgeons. Although much progress has been made during recent years, results of repair of these lesions are far from perfect.

Ætiology of Strictures of the Common Duct

Although numerous factors are identified as being responsible for strictures of the common duct (see Table 1) operative trauma is the most common single factor encountered.

TABLE 1

CAUSES OF BENIGN STRICTURES OF COMMON BILE DUCT

(1) *Operative Trauma :*
    (a) Excision (thought to be cystic duct).
    (b) Ligation (usually with bleeding vessel).
    (c) Cystic duct ligature too close.
    (d) During gastrectomy.
(2) *Inflammation* (Obliterative Cholangitis) :
    (a) Related to cholangitis.
    (b) Abscess or collection of bile about duct.
    (c) Pylephlebitis.
(3) *Secondary to Pancreatitis.*
(4) *Ulceration due to Gall Stones.*

Operative Trauma.—In a series of 49 cases observed over a period of 11 years, operative trauma definitely appeared to be the cause of the lesion in about 65 per cent. of cases (see Table 2).

TABLE 2

INITIAL CAUSE OF BENIGN STRICTURE
(In our series of 49 patients)

Cause of Stricture	No. of cases	Per cent.
(1) Operative trauma	32	65
(2) Inflammation	11	23
(3) Chronic Pancreatitis	5	10
(4) Pancreatic cyst	1	2
TOTAL	49	100

Although the exact mechanism in the production of the damage cannot be determined accurately, the most common one is probably excision of the common duct at the junction of the cystic and common ducts. In some patients the duct is unusually mobile and when traction is placed on the gallbladder, the calibre of the common duct may be decreased, and being continuous with the cystic duct, it may resemble the latter structure. If the surgeon is careless or in a hurry he may erroneously consider the common duct to be part of the cystic duct, and excise it with the gallbladder.

On other occasions hæmorrhage resulting from injury to arteries (usually anomalous) is the cause of injury to the duct. An accessory cystic artery is present in 15 per cent. of cases (Flint(1)) and may be the direct cause of bleeding since its presence will be unsuspected, once one of the cystic arteries has been tied. A severed loose cystic artery usually retracts to its point of origin, posterior to the common duct. If the surgeon does not appreciate this relationship, the common duct may be damaged by the artery forcep or by the ligature placed on the bleeding point.

Although effort should be made not to leave a long stump of cystic duct, care must be taken lest the lumen of the common duct be jeopardized by the ligature of the cystic duct. This will be discussed later in more detail.

When gastrectomy is being preformed for duodenal ulcer there is danger of injury to the common duct, particularly if an ulcer is located low in the duodenum and the surgeon removes it. Rarely, indeed, docs a stricture follow choledochostomy ; in our series of 49 cases of stricture, not one followed that procedure.

Inflammation.—In 23 per cent. of our series inflammation was considered to be the primary cause of the stenosis, largely because jaundice did not occur for 6 months to 2 years following operation. In some cases it is possible that a small abscess formed in the neighbourhood of the common duct (perhaps secondary to large masses of sutures and ligated tissue)· and the resultant inflammation ultimately caused cicitrization of the wall of the duct. On other occasions a small collection of bile overlying the common duct may have given rise to the stenosis. The massive dense adhesions found in the upper abdominal cavity of patients having had a biliary fistula is proof of the severe inflammation produced by bile.

On three occasions we have observed a stricture of the common duct in patients with pylephlebitis. No proof is available that the inflammation produced by the phlebitis was the primary cause of the stricture, but in each case the inflammation about the portal vein was so severe that serious damage to adjacent structures such as the common duct might have been expected.

Although the ordinary type of suppurative cholangitis which occasionally accompanies obstruction of the duct by stone or carcinoma of the head of the pancreas, rarely gives rise to stricture formation, an

obliterative type of cholangitis (in the common duct) does exist. For example, we have observed several centimetres of fairly normal common duct at one operation, but at an operation several months later found that portion of the duct to have stenosed down to a structure with a lumen scarcely as large as a fine probe. This type of lesion is perhaps best classified as obliterative cholangitis.

Chronic Diffuse Pancreatitis.—In five of our patients (10 per cent.) the stricture was located in the pancreatic portion of the duct, and was secondary to diffuse sclerosing pancreatitis. This group does not include localized pancreatitis of the head of the pancreas, a lesion which markedly resembles carcinoma, but with very few exceptions resolves spontaneously in a few months.

Prevention of Stricture

Since strictures are so commonly caused or followed by operative trauma, we should be particularly careful to avoid any technical errors which might give rise to stricture. Careful observance of numerous precautions will minimize stricture formation.

(1) *Obtain Good Exposure*

Numerous incisions including longitudinal, transverse and oblique ones have been recommended for cholecystectomy. The author is convinced that no one incision can be considered superior to the other, but it is true that as a surgeon becomes accustomed to one incision he will do better work if he utilizes that one routinely. The important feature is to obtain ample exposure so that all structures can be identified accurately ; this facilitates proper dissection without danger of accidental injury to vital structures. A long incision is recommended since this heals at about the same speed as a short one. It is essential to have good anæsthesia since operating on a patient with poor relaxation prevents proper exposure of the vital structures, particularly those around the common duct and hilus of the liver.

(2) *Isolate Junction of the Common Duct Before Ligating the Cystic*

Since one of the most common types of injury to the common duct is excision of a portion of it with the cystic as the gallbladder is retracted upward, it is absolutely essential to obtain good dissection of the junction of these two ducts. Peritoneum of the common duct should be incised and the junction isolated.

(3) *Ligate no Artery Until Proven it Enters the Gallbladder*

Since anomalies of blood vessels and other structures are extremely numerous in this area one cannot rely upon textbook anatomy, but must make careful observations to identify structures. A pulsating vessel may be the cystic artery, the right hepatic or the common hepatic artery. If the surgeon can prove the artery enters the gallbladder itself it is safe

to assume that it is the cystic. It is extremely important not to make the error of ligating the right hepatic artery since ligation of this vessel results in death of the patient in about half the cases. A great many of the patients dying of so-called acute liver insufficiency have actually had accidental ligation of the right hepatic artery.

(4) *Ligate the Cystic Duct and Artery Separately*

By dissecting these two structures one from the other, the surgeon can avoid the possibility of ligating a portion of the common duct, which could readily happen if the entire mass containing duct and artery was ligated with one ligature.

(5) *Ligate the Cystic Duct One Half-Inch from the Common Duct*

Many surgeons emphasize the necessity of ligating the cystic duct close to the common duct to prevent formation of a bulbous tip and possible recurrence of symptoms. This advice is sound except that if followed too literally the ligature may be placed so close as to pucker the wall of the common duct and thereby infringe on the lumen. If a ligature of large sized catgut is used to ligate the cystic duct there is definitely slight danger of sufficient inflammation in this area to injure the common duct. Accordingly, the author wishes to emphasize that the ligature should be placed about one half-inch from the wall of the common duct and preferably should be a non-absorbable suture.

(6) *Cut no Structure until Identified*

This rule must be observed rather closely since there are several structures including the common duct, portal vein and hepatic arteries which must not be injured. Careful identification of structures must be made because of the frequency of anomalies as already emphasized.

(7) *Control Hæmorrhage by Pressure to Facilitate Isolation of the Bleeding Point*

When hæmorrhage is encountered through injury to a vessel or slipping of an artery forceps, great care must be exercised in its control since injury to the common duct during control of hæmorrhage is perhaps the second most common mechanism in production of stricture. Stabbing for the vessel blindly with an artery forceps may catch the bleeding point, but so commonly a portion of the common duct will be included in the clamp, because the bleeding vessel usually retracts posteriorly beneath the common duct. To avoid danger of injury, control of the bleeding point can be achieved readily by inserting the index finger of the left hand into the foramen of Winslow and pressing the hepatic artery between the index finger and thumb. When the vessel is controlled in this manner pressure can be released gradually and the bleeding point carefully isolated.

(8) *When Adhesions are Dense Around the Common Duct Start Dissection of the Gallbladder at the Fundus*

Adhesions around the common duct as well as the cystic duct are usually so diffuse that all anatomical landmarks are obliterated. If the

adhesions are dense it may be impossible to find a plane for dissecting out various vital-structures. Under such circumstances it is usually very dangerous to attempt dissection of the cystic and common duct as the initial part of the operation. It is usually much safer to start dissection of the gallbladder from its bed at the fundic end. Although it is very highly desirable to remove the entire gallbladder and all the cystic duct except the distal half-inch, it is far better to leave a portion of the ampulla of the gallbladder than to attempt thorough dissection in the presence of dense adhesions with the possibility of resultant damage to vital structures. Unfortunately, starting dissection at the fundic end one usually encounters considerable bleeding which, however, can be controlled by packs and transfixing ligatures.

(9) *A Knowledge of the Normal and Abnormal Anatomy is Essential*

Nowhere in the human body are anomalies so common as in the region containing the bile ducts and adjacent blood vessels. Although a knowledge of normal anatomy will be extremely helpful in avoiding damage to vital structures it will not prevent damage unless the surgeon is likewise familiar with the various possibilities in anomalies, and recognizes them when present.

Pre-operative Care

Patients with strictures of the common duct when first seen are usually poor operative risks. There are several reasons for this. As jaundice is fairly constant the ill-effects of this complication, which include loss of appetite, loss of bile for digestive function, and loss of electrolyte if a fistula exists, can readily result in depreciation of physical reserve. Anæmia and hypoprotanæmia are extremely common. A variable degree of hepatitis is present in practically every patient; as proved by positive cultures obtained from samples of bile at operation. On some occasions the infection is severe enough to produce chills and fever. In such circumstances suppurative cholangitis is invariably the explanation of the symptoms. When this complication develops, it is usually necessary to drain the common duct before attempting any repair of the stricture since chemotherapy is so ineffective in cholangitis, secondary to obstruction of the common duct. Due to infection, insufficient caloric intake and other abnormal circumstances, a variable degree of hepatic insufficiency will therefore be present in almost every patient. If the surgeon is not fully aware of the various decrements produced by common duct obstruction, and operates on these patients before these deficiencies are corrected, the mortality rate will be extremely high.

Numerous procedures will be necessary to improve the operative risk. One of the most important is correction of the anæmia and hypo-protanæmia by the use of ample transfusions. The surgeon and dietitian must co-operate fully in obtaining the maximum caloric intake. If the patient is unable to eat a sufficient quantity of food to improve his physical

condition he should be given intravenous glucose daily. Small quantities of amino acids can be given daily but at a very low rate of injection. If a biliary fistula is present it may be necessary to give electrolytes intravenously to maintain balance.

Proper pre-operative therapy as well as post-operative therapy is therefore essential in the maintenance of a low operative mortality.

Repair of Strictures

Since numerous types of stricture are encountered it is obvious that numerous types of therapeutic measures would be necessary in the operative correction. To treat lesions intelligently the surgeon must be familiar with the numerous procedures available and be aware of their indications. When a stricture is present in the common duct the amount of adhesions in the area is enormous. These adhesions are usually so dense that blunt dissection is impossible. Since sharp dissection is therefore necessary, the surgeon must be very careful in his dissection, lest vital structures be damaged. Starting dissection in the lateral anterior portion and proceeding downward alongside the ventral surface of the liver, will usually minimize the danger of accidental injury to vital structures. Since the common duct normally lies anterior and slightly to the right of the portal vein it would protect the vein to some extent ; however, it must be recalled that in a great many cases all remnants of the common duct will have been destroyed, thereby leaving the portal vein open to injury with the knife by sharp dissection. When the region of the hilus or portal vein is approached the aspirating syringe should be used freely to identify portal vein and common duct. Aspiration of the portal vein does no harm since oozing of blood through the needle puncture ceases rapidly.

If possible, it is exceedingly important to find the distal end of the common duct because the sphincter mechanism at the sphincter of Oddi is a very effective mechanism with a function very difficult to reproduce by operative means. Cattell (2) has emphasized the importance of dissecting posteriorly beneath the duodenum after incising the peritoneum along its lateral border, and searching for the common duct, even though pancreatic tissue must be divided to find it.

Regardless of the type of repair contemplated, ample exposure of the various structures must be obtained. The type of repair will depend upon the type of stricture encountered.

(1) *Local Strictures*

When the stricture involves a local area of the common duct, repair is more easily performed and associated with better results. The stenosed area should be excised widely enough to obtain a fairly normal duct wall ; repair should be instituted with interrupted sutures of fine silk or cotton, taking care not to take the bite in the wall of the duct so deeply as to allow the suture to project into the lumen, since the presence of a suture

in the lumen of the duct might give rise to development of concretions. In spite of the fact that this type of repair heals quite readily, the suture line should be furnished with some type of support. This support is best accomplished by the arm of a T tube. However, the T tube should be inserted through an opening at least one half-inch distant from the suture line because insertion at the suture line tends to encourage recurrence of the stricture.

(2) *Stricture of the Distal End Only*

When the stricture involves only the distal end of the common duct several types of technique are available for repair. The one preferred by the author is a *side-to-side anastomosis* utilizing longitudinal incisions in the common duct and in the intestine. When several centimetres of proximal duct are available the duodenum is used in the anastomosis. To achieve a lateral type of anastomosis as previously described, the duodenum will have to be mobilized somewhat by incision of the peritoneum along its lateral margin and the duodenum and head of the pancreas mobilized upward. The use of a longitudinal incision in the common duct is probably superior to the use of a transverse incision because it should jeopardize the lumen of the common duct slightly less than the transverse incision. When repair as outlined above is utilized, an outside row of non-absorbable interrupted sutures (silk, linen or cotton) should be used, the inside row should consist of interrupted 0000 catgut. The utilization of a continuous suture in this anastomosis seriously jeopardizes the stomal opening because of the puckering effect produced.

Transplantation of the stump of the common duct into the duodenum is considered a suitable operation by many surgeons although the author has had less fortunate results with it than with the method above described. The suture line should be executed in the same manner as already described utilizing interrupted non-absorbable sutures for the outside layer and interrupted 0000 catgut for the inside layer. When this procedure is performed it is advisable to insert a short piece of soft rubber tube through the opening down into the duodenum so that a few centimetres of tubing project on each side of the anastomosis. Insertion of a support of this type prevents or minimizes the danger of narrowing of the lumen by sutures. Although the tube may appear to be anchored fairly snugly at the completion of the operation, the tube drops out within a few weeks with practically no exceptions.

(3) *Stricture of the Proximal Portion of the Common Duct*

When the proximal duct is missing but the distal end present, the type of repair indicated varies from those described previously although it is similar to the repair of local stricture. However, the duodenum and head of the pancreas must be almost completely mobilized to allow the distal end of the duct to meet the hilar duct. When mobilization has been achieved sufficiently to allow approximation of the two ends of duct

without tension they are joined in an end-to-end fashion with interrupted sutures. The type of suture indicated in this repair is somewhat controversial but in general, fine non-absorbable sutures should be utilized, taking particular precautions not to have the suture project through the wall into the lumen, because of the danger of formation of concretions. Before the end-to-end repair is completed the arm of a T tube is inserted through an opening at least one half-inch distal to the anastomotic line. If non-absorbable sutures are used in the end-to-end anastomosis one row will be adequate, and in fact desirable, since two rows might tend to jeopardize the lumen. The opening in the duct through which the T tube merges should be closed securely to prevent leakage of bile. The arm of the T tube must extend at least one half-inch above the suture line and on occasions may project against the point of bifurcation of the two ducts within the liver. This T tube should be left in place for at least three months because the process of cicatrization extends over a similar period.

(4) *Absence of Entire Duct*

This type of defect is the most difficult of all to repair, and results are generally not as good as in those already mentioned. The author [3] prefers the use of the Roux Y arm of jejunum as practised also by Allen [4]. This procedure is not new having been recommended as long ago as 1908 by Monprofit [5]. The author is convinced of the advantage of the Roux Y arm, primarily because it represents a defunctionalized loop of intestine thereby eliminating regurgitation of intestinal contents with consequent infection. The Roux Y arm is constructed by transecting the jejunum about two feet from the ligament of Treitz. The proximal end is then implanted into the distal part of the jejunum at least 15 inches from the point of transection, to eliminate the possibility of regurgitation. The free arm of the jejunum is then brought upward to meet the hilar duct anterior to the colon or through the opening in the mesocolon if the mesentery of jejunum is short.

Use of a Vitallium Tube.—There are obviously several variations in the method of anastomosis between the hilar duct and the end of the jejunum. Originally, the author preferred to invert the stump of the jejunum leaving a small opening in the centre through which a vitallium tube was inserted ; the funnel end of the tube is inserted up into the liver, and the arm of the tube down into the jejunum. The vitallium tube can be anchored in place in the hilar duct by insertion of a purse string suture around it. Utilizing this procedure the vitallium tube can be held in place almost indefinitely ; however, it is not essential or, perhaps, even desirable to have the vitallium tube remain in place indefinitely since it will usually become plugged with bile precipitates if left there long enough. Recently, the author has anchored the vitallium tube in place with two interrupted sutures of silk to the walls of the hilar duct (without the use of a purse string suture), and has then fixed the end of the jejunum to the edges of

the hilar duct with numerous sutures of interrupted fine silk. Employment of this method is more likely to be followed by biliary fistula than utilization of the purse string type of repair mentioned above. However, these fistulas always close, and if adequate drains are placed down to them, it is doubtful that any harm results even if they do form. By taking each of the sutures attached to the vitallium tube deeply in the scarred surface of the liver one can be fairly certain that the tube will remain in place for at least three months.

Use of a Rubber Catheter.—To obviate the disadvantage of blockage of the vitallium tube, Allen (4) has recommended use of the bell end of a rubber catheter to furnish support at the suture line between the hilar duct and between the arm of the jejunum. He inverts the end of the jejunum thus forming a cuff and attaches this cuff end to the hilus around the hilar duct. The end of the catheter protrudes past the suture line up against the junction of the two ducts in the liver. The catheter is brought out through the wall of the jejunum three or four inches from the suture line and is led out through the wound to the exterior. Penrose drains are inserted down to the area of anastomosis but the catheter is left in place at least three months. A hole is made in the wall of the catheter inside the lumen of the jejunum to allow some of the bile to flow into the intestinal tract.

Use of Mucosal Graft from the End of Jejunum.—When the stricture is located at the hilus of the liver and no duct wall is available, there is great danger of recurrence of the stricture regardless of what type of repair is performed. For these types of stricture the author has recently been using a modification of the Hoag principle by utilizing a flap of mucosa. Instead of taking the flap from the stomach as advocated by Hoag, the author forms a mucosal flap in the end of the Roux Y arm of jejunum by separating the mucosa and submucosa from the muscularis and serosa (see Fig. 6). This allows formation of a thin flap of mucosa and submucosa which after anchoring a small rubber tube in its lumen can be inserted upward into the opening made in the liver connecting with the dilated intra-hepatic duct. The purpose of this procedure is to have the mucosal flap approximated against the tissue at the hilus so that it will adhere as a graft, and prevent cicatrization. Use of skin grafts in prevention of cicatrization is well known in other types of repair. The rubber tube is held in place by two or three interrupted silk sutures between the wall of the jejunum and wall of the opening at the hilus. Repair of this type is seldom followed by a biliary fistula. Although the author has used this operation on only four patients, results to date have been very gratifying.

(5) *Anastomosis of the Gallbladder to the Duodenum or Jejunum*

If the gallbladder is present and the stricture is of the malignant type beyond the possibility of resection, it may be anastomosed to the

duodenum or jejunum to allow bile to enter the intestinal tract. This type of operation is easier than anastomosis of the common duct to a loop of intestine. However, in the author's opinion it should be used only when life expectancy is short. Regurgitation of food through the stomach into the gallbladder is very undesirable and infection would appear to be a strong probability. In the presence of an inoperable carcinoma the amount of infection developing within the few remaining months of life would probably not be very serious. The amount of infection can be minimized by anastomising the gallbladder to a defunctionalized loop of jejunum. However, when this is done it is preferable to create folds in the ascending or proximal arm of jejunum to ensure that the food stream will pass through the opening made between the two arms of jejunum, and thus minimize the danger of regurgitation (Peterson and Cole).

Results

For the sake of clarity the results of 63 operations in 49 patients are summarized in Table 3. In 28 patients upon whom we performed operation suturing the hilar duct to the Roux Y arm of jejunum, 78 per cent. had good to excellent results, whereas in 22 per cent. the operation was a failure.

TABLE 3

SUMMARY OF RESULTS IN REPAIRS OF STRICTURES
(63 operations in 49 patients*)

Type of Operation	No. of Oper's	Results (exc. op. deaths)	Oper. deaths
Hilar duct to Roux Y (80% vit. tubes)	28	78% good to exc. 22% failure	0
Hilar duct to Mucosal flap Jej. (modified Hoag op.)	4	75% good to exc. 25% failure	0
Repair local stricture	7	86% good to exc. 14% failure	1
Hilar duct to Duodenum	7	14% exc. 28% fair 58% failure	0
Miscellaneous Types of Oper.	17	60% good to exc. 40% failure	3
Summary	63		4

Operative Mortality Rate 6%

* Not counting one patient in whom no type of repair was possible because no duct could be found at the hilus.
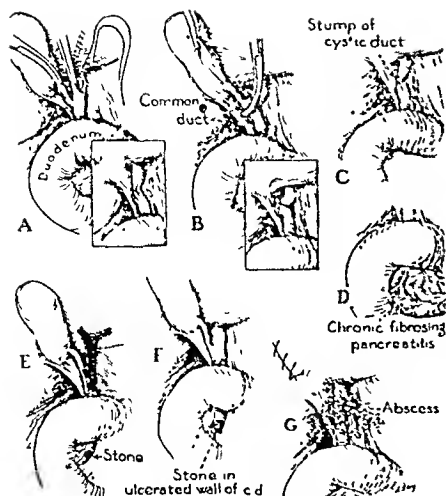
Fig. 1. Mechanisms in production of stricture of the common duct. A. Transfixion with a needle. B. Ligation with the cystic. C. Ligation of the cystic duct too close to the common. D. Diffuse sclerosing pancreatitis. E. Cholangitis F. Ulceration of the wall by stone. G. Abscess or local collection of bile. (From Cole, Ireneus and Reynolds in *Strictures of the Common Duct*, Interscience Pub. Co., N.Y., 1948.)
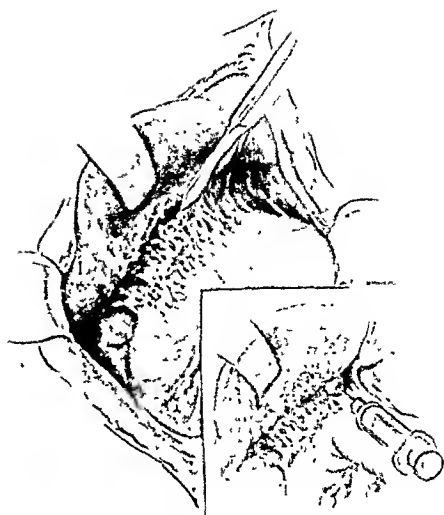
Fig. 2. The safest approach to the region of the hilus of the liver is from the antero-lateral quadrant. As the region of the hilus is approached, an aspirating needle should be used freely to identify such strictures as the portal vein, and proximal stump of the common duct. (Modified from Cole, Ireneus and Reynolds in *Ann. Surg.*, 1945.)
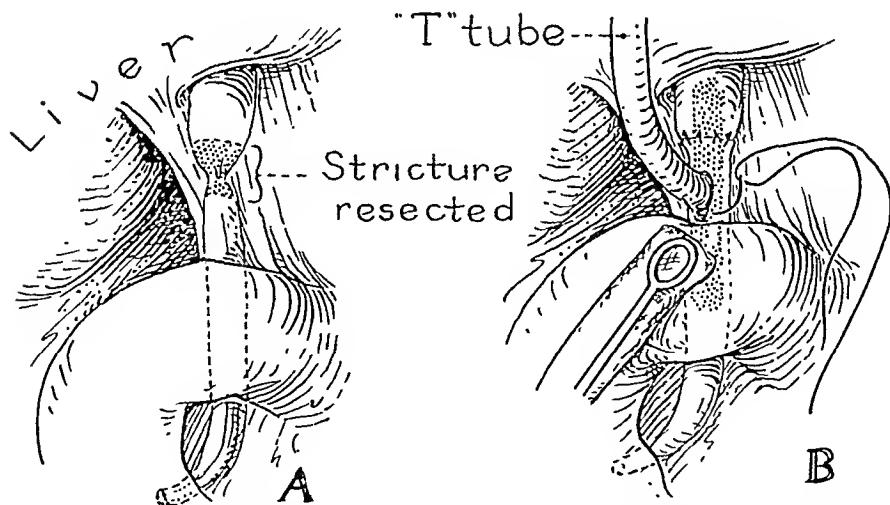
Fig. 3. After resection of a local stricture an end to end anastomosis represents the most satisfactory type of repair. A single row of interrupted sutures, preferably non-absorbable taken with a shallow bite, is utilized. A T tube is inserted through an opening above or below the suture line (not through it), and the opening closed around it with interrupted fine catgut. The T tube, with one arm projecting above the suture line should be left in position for three to four months. (From Cole, Ireneus and Reynolds in *Strictures of the Common Duct*, Interscience Pub. Co., N.Y., 1948.)
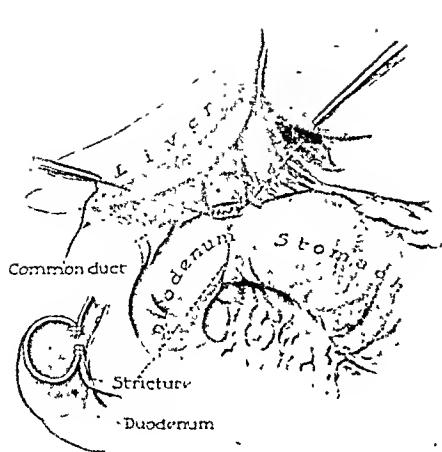
Fig 4. When the distal end of the common duct is stenosed but several centimetres of the proximal portion remain, a side to side anastomosis between the duodenum and common duct is a suitable procedure for repair. A longitudinal incision of the common duct as described in the text is probably superior to the transverse incision illustrated above. (From Cole, Ireneus and Reynolds in *Strictures of the Common Duct*, Interscience Pub. Co., N.Y., 1948.)
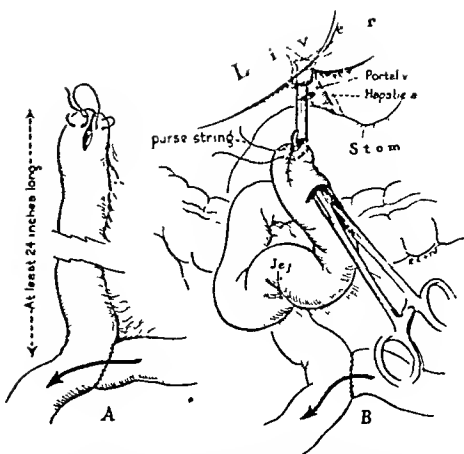
Fig. 5. When utilizing the Roux Y arm of jejunum to replace the common duct the ileum is severed about 18 inches from the ligament of Treitz and the proximal end sutured to the distal loop at least 14 inches from the point of severance ; the distal end is closed with a continuous suture as shown in A. The end of the vitallium tube is inserted into the end of the intestine, aided by a hemostat through a puncture wound two or three inches from the closed end as shown in B. (From Cole, Ireneus and Reynolds, in *Ann. Surg.*, 1945.)
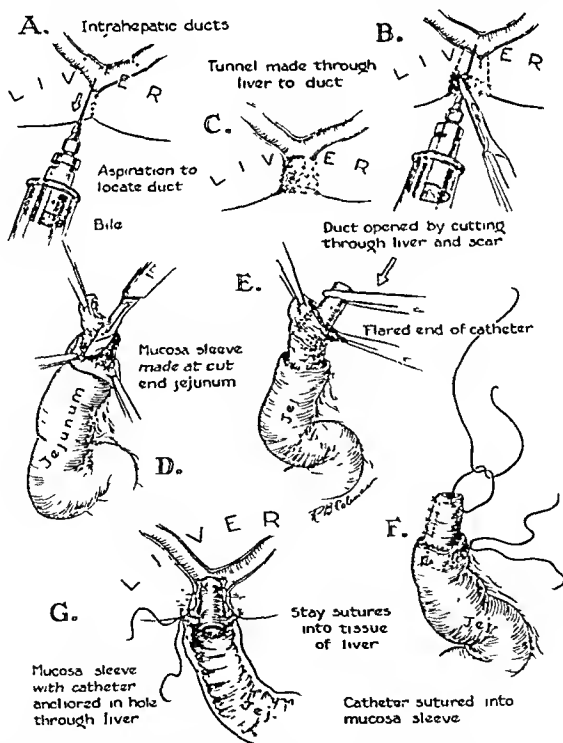
Fig. 6. When the stricture is located at the hilus, there is much greater probability of recurrence, particularly when scarred liver tissue must be incised to expose the duct A sleeve graft of jejunal mucosa (Modified Hoag operation) is constructed at the end of the Roux Y arm of jejunum, and inserted up into the opening with the end of a catheter for support. The depth of liver margin usually traversed is exaggerated to better illustrate the procedure although on two occasions we were not able to find an intra-hepatic dilated bile duct except at a depth of 1.5 inches. (From Cole in *Canadian J. Med. Assn.*, 1948.)

In four patients we utilized an operation which we have been performing recently. As stated it is a modification of the Hoag operation and is designed to attempt to have a graft of jejunal mucosa adhere to the walls of the opening at the hilar duct, particularly when several mm. of liver tissue must be opened before the lumen of the duct is entered. In this group of four patients we had good to excellent results in 75 per cent. ; in one patient listed as a failure the patient has had attacks of jaundice at intervals but symptoms are so mild that he prefers not to have additional operative work done. We would predict a failure in this case, because we could not find the common duct at the hilus and had to make a tunnel exactly 1½ inches long into the liver alongside our aspirating needle before we could open into a dilated duct. This series of four cases is obviously too small from which to draw any comparative conclusions regarding the efficacy of the technique.

In seven patients we have repaired a local stricture. One of these seven died post-operatively ; the other six had good to excellent results.

On seven occasions we have anastomosed the hilar duct to the duodenum. Although a few of our surgical friends have had fairly good results with this technique our results have been very poor indeed. Only one of seven cases has had results which could be considered good or excellent. Two of them had fair results but the remainder represent failures. For this reason we abandoned the old traditional procedure of anastomosing the hilar duct to the duodenum.

In 17 patients we have utilized miscellaneous types of operations which have yielded relatively poor results, and represent methods which we have abandoned.

In our series of 63 operations we had four deaths representing a mortality rate of 6 per cent. A few years ago Walters (6) reviewed a series of 98 cases with a mortality rate of 10 per cent. Cattell (2) reported a mortality rate of 13.8 per cent. in 123 cases.

In 1946 Pearse (7) summarized results of numerous workers in this field and noted that results were considered good in 80.1 per cent. of 106 patients upon whom a vitallium tube had been implanted into a loop of jejunum for repair of a stricture. He noted that recurrence of symptoms caused by blockage of the tube occurred in 11.3 per cent. of his combined series. In 79 patients the vitallium tube was used to support the suture line attaching the duodenum to the hilar duct ; in only 58.2 per cent. of this group were results considered to be good. It is also my opinion that this method of utilizing a vitallium tube for support of a suture line between the duodenum and hilar duct would not yield good results.

Some surgeons anastomose the hilar duct to a loop of jejunum and perform an entero-enterostomy between the two arms of the jejunum

about 8 or 10 inches from the point of anastomosis. In our early experience with strictures of the common duct we utilized this procedure, but had such poor results that we abandoned it. In five patients upon whom we performed this operation we had failure in four. One patient had symptoms consisting of occasional attacks of jaundice, chills and fever for two or three years but finally cleared up and has had no symptoms for the past three years. In two of the other cases symptoms recurred soon after operation but disappeared completely after we transected the proximal arm of jejunum, thus preventing regurgitation of food and intestinal content up into the intra-hepatic ducts. In those two patients nothing was done except to transect the jejunum and preventing regurgitation.

Appreciation is hereby expressed to John Reynolds and Carl Ireneus for assistance in this study.

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THE VOLATILE ANÆSTHETICS—THEIR PRESENT STATUS

Lecture delivered at The Royal College of Surgeons of England

on

10th October, 1947,

by

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LAST YEAR'S CENTENARY of the introduction of ether into surgical practice and the imminence of that of chloroform which will be celebrated on the 4th of November of this year have brought once again into the limelight of criticism the two original major agents of general anæsthesia. The long sustained rivalry between those doughty veterans faded out years ago, but now the supremacy of ether, the winner, is being challenged by younger members of the family of volatile anæsthetics and by non-volatile barbituric obtruders. Undoubtedly, these new drugs and methods have manifest advantages in skilled hands but to some extent they share with ether a diminution in favour because of the evolutionary changes which are now threatening to reduce the status of general anæsthesia by relegating it to the lesser but still relatively important duty of establishing and maintaining unconsciousness only. The fundamental function of producing adequate relaxation is tending to pass from the general anæsthetic drugs to agents and methods which can satisfy the requirements of the surgeon without a poisonous saturation of all the tissue cells of the body. Thus the revival and technical improvements in regional analgesia and the introduction of a specific relaxant, dextro-tubocurarine chloride, are evidence of a determined effort to abolish or at least modify the dependence on general anæsthetics of the anæsthetist and surgeon. The toxicity of the older general anæsthetics was undoubtedly a hindrance to progress in operative surgery which could not have reached its present high level under chloroform and ether except at an unwarrantable cost in lives and morbidity. Surgeons have felt, not without considerable reason, that their results could be much improved if deep general anæsthesia and its toxic effects ceased to be associated with surgical interventions—a sentiment with which most anæsthetists would agree.

Changes in anæsthetic procedure have been many in the past few years. It may be that specialisation and specialists with a constant urge to have something different but not necessarily better are partly responsible for the innovations that have taken place, but there have been other activating factors. Thus, the widening of the horizons of surgery has done much to stimulate and encourage the developments in anæsthesia of recent

10—2

years, but most surgeons would readily admit that a considerable degree of reciprocity has facilitated and favoured advancement in both spheres.

During periods of rapid change it is difficult for any single individual, working with relatively limited amounts of experimental or clinical material, to assess dispassionately the values of different methods. A realisation of this fact prompts one to be cautious in making critical comparisons. Nevertheless, it is important to review one's own work and that of others periodically in order to restrain oneself from riding hobby horses too hard, or at the other extreme, avoid being " tailed off " in the field of progress.

The present status of the volatile anæsthetics is a subject which affords ample scope for controversy. Properly speaking, the term " volatile anæsthetics " includes two physically differentiated groups. In the first group are nitrous oxide, ethylene, acetylene, cyclopropane and ethyl chloride, all of which are gaseous at normal atmospheric pressure and temperature. The second group consists of di-ethyl ether, di-vinyl ether, chloroform, trichlorethylene and two recent additions, cyclo-propyl methyl ether and cyprethylene ether which are still undergoing clinical trials. These, under normal conditions of pressure and temperature, are liquid in form and have to be volatilised immediately prior to inhalation. All the volatile agents are non-reactive, that is to say, they enter the patient's lungs, gain access to the tissues and when the period of anæsthesia is to be terminated, they leave again unaltered. This is in marked contrast to the fate of the reactive non-volatile drugs such as the barbiturates which depend on katabolic processes to detoxicate them and initiate their elimination.

Apart from nitrous oxide and ethyl chloride, which are practically equal in seniority to ether and chloroform in the family group, the gases form a younger generation which, in the natural order of things, has been trying hard to oust the older members from their firmly established precedence. The *enfant terrible* is undoubtedly cyclopropane, a precocious but likable youngster who, with his winning but slightly aggressive ways, has made existence somewhat more difficult for his seniors—chloroform and ether.

Before discussing the more important distinguishing features of the volatile anæsthetics in common use, it is necessary to consider the main criteria by which they should be judged. These are : (1) safety and (2) effectiveness. In regard to (1) safety, the several factors involved are toxicity, degree of fixation in the tissues, flexibility of control and inflammability. The toxicity of a drug may, at the time of its administration, endanger a patient's life and later, because of delayed effects, increase the hazards of the post-operative period. In respect to the latter, it must not be forgotten that some of the post-operative sequelæ considered peculiarly surgical may be associated with the anæsthetic procedure. Thus interference with intestinal motility by deep general anæsthesia may have repercussions in the post-operative period just as serious

as the respiratory and circulatory depression which are commonly accepted features of anæsthetic toxæmia. Generally speaking, toxicity and safety in respect to any anæsthetic agent are in inverse ratio to one another. To a large extent also the degree of fixation of a drug in the tissues is related to toxicity, chloroform and ether being examples of drugs of high lipoid solubility which become more fixed than others. Equally important in achieving safety is the virtue of flexibility of control. This factor is largely affected by the lag in absorption and elimination associated with each drug. The more slowly the anæsthetic agent is absorbed, the less readily can variations in depth of anæsthesia be obtained and this applies equally to the reverse process of elimination. Many present day operations require fine adjustments in the level of anæsthesia if the patient is not to be grievously affected at the end of a long anæsthetic. The old ideal of a constant level, usually deep, will not do in long and extensive operations ; there are better alternatives to this. Inflammability of anæsthetic agents is a factor affecting safety which is well enough understood and needs no further discussion here.

(2) `Effectiveness : By this term is meant the degree of relaxation obtainable by the agent used. This is directly proportional to the potency of the drug and potency is closely related to toxicity. Effectiveness is also enhanced by flexibility of control which enables the anæsthetist to vary quickly the depth of anæsthesia to suit different stages of an operation. Other features that should not be forgotten in assessing effectiveness are the extent to which the surgical procedure is facilitated or hindered by such things as hæmorrhage and excessive respiratory movements in so far as these may be related to the anæsthetic agent or technique.

Flexibility of control with which one has associated both safety and effectiveness is best seen when agents such as nitrous oxide and cyclopropane are employed. It may be claimed that there is a certain degree of flexibility in the control of intravenous barbiturates but in deep anæsthesia under such agents, this is negligible because of a considerable lag in elimination caused by the depression of oxidative metabolic processes which accompanies such anæsthesia. With no possibility of their ejection through the swing door of the lungs, the control of these reactive agents' cannot truly be considered flexible.

Having discussed the criteria, their application to the anæsthetic agents in common use must now be considered.

Nitrous Oxide : At the end of the first World War, nitrous oxide had acquired a reputation as an anæsthetic of great value for ill patients because of its lack of toxic effects. Its limitations unfortunately were not always understood by physicians and surgeons and the demands for its use in unsuitable circumstances threw a considerable strain on anæsthetists who realised its inadequacy particularly in abdominal surgery. This led to a considerable amount of subterfuge and hypocrisy. On the one hand, one found in America the introduction and advocacy of the technique of secondary saturation, a process which defied to the limit the

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maintenance, or survival even, of respiratory and circulatory function; on the other, there was the frequent, illicit use of ether which masqueraded dishonestly as gas and oxygen, thus increasing the credulity of anosmic, short-sighted or less intelligent bystanders. Occasionally, too, in such circumstances, chloroform was added to the nitrous oxide, being euphemistically ' referred to as " holy water " by those who indulged in this practice. With their 100 per cent. potency the supplementary ether or chloroform could be depended upon to produce the desired depth of anæsthesia.- Such manœuvres proved plainly the anæsthetic ineffectiveness of nitrous oxide and at the same time their surreptitious character indicated an expectation of untoward effects from the supplementary agents. Summed up briefly, nitrous oxide is non-toxic and flexible in control so that, properly handled, it ought to be the safest of all inhalational anæsthetics but used alone its effectiveness in operations requiring any relaxation is practically nil.

Chloroform and Ether: Much has been written about these agents. Their respective merits and demerits have been discussed for a century. It is natural, therefore, in discussing the status of the volatile anæsthetics that considerable attention should be given to these two and particularly to ether. Whither are they going? There can be little doubt about the eclipse of chloroform. This is almost total—even in Scotland where it was born—in so far as its use in general surgery is concerned. Will ether follow chloroform into desuetude? It is my belief that it will.

Applying the criteria of safety and effectiveness, what can be said of chloroform and 'ether? Firstly, in regard to safety, the toxicity of both agents is admitted by all, that of ether being less only in degree. Chloroform is hazardous during its administration and detrimental in the post-operative effects which follow its use. It is little consolation that it is non-inflammable. Flexibility of control with chloroform is poor, particularly in the deeper planes of anæsthesia. Secondly, as regards its effectiveness, there can be no doubt that because of its potency, it is 100 per cent. effective and therefore can produce all that was desired of anæsthesia in former days, namely, maximal relaxation. It also causes a definite lowering of blood pressure and quiet respiration—both very agreeable things for the surgeon. But after saying all that, it must be agreed that the price paid for these advantages, particularly if the operation is an extensive one, is much too high.

One treads on much more debatable ground when discussing ether. Over and over again the safety of ether has been emphasised and there is no doubt that the immediate risk to the patient under ether is much less than under chloroform or indeed most other agents. With it there is no sudden circulatory or respiratory failure. Nevertheless, the maxim " safety first " should not be followed slavishly if the well-being of the patient is to be considered broadly in both operative and post-operative

phases. Prolonged deep anæsthesia under ether may bring a trail of after-effects, respiratory, circulatory and metabolic, which all too frequently prejudice a patient's chances of recovery after a severe operation and even in their mildest form produce discomforts which add nothing to the reputation of the agent or of the one who administers it. From the patient's point of view, ether is probably the most distasteful anæsthetic of all. The effectiveness of ether, as in the case of chloroform, is 100 per cent., but the concomitant advantages of reduced bleeding and quieter respiration are absent. Flexibility of control of ether is better than that of chloroform but here again except in light planes of anæsthesia, purposive variations in level take place rather slowly.

Even in the heyday of chloroform and ether, when operations were less extensive and took a much shorter time, other methods were frequently preferred in many parts of the world. The noxious effects of the former were generally recognized and the continual search for other methods of securing muscular relaxation would appear to indicate that whilst chloroform and ether were admittedly satisfactory in that particular respect, they had side actions which were most undesirable and sufficient to discourage their use if alternative agents and methods were available.

Brief consideration must be given to ethyl chloride and trichlorethylene, two chlorinated hydrocarbons which are used fairly frequently at the present time.

Ethyl chloride is extremely volatile. It is rapidly absorbed so that a deep plane of anæsthesia is reached quickly and is equally rapidly eliminated. In this way it might be considered flexible in control but unfortunately like all anæsthetic agents with a halogen atom in the molecule, it has a marked direct, depressant action on cardiac muscle. Such toxicity is to a considerable extent counteracted by the factor of quick elimination and therefore this agent can be used with a reasonable degree of safety and efficiency in a restricted class of work, namely, anæsthesia for minor surgery—for example, the removal of tonsils and adenoids by the guillotine, the extraction of teeth or incisions of abscesses.

Trichlorethylene on the other hand is much less volatile and so far as flexibility of control is concerned, it corresponds more closely to chloroform and ether. It is difficult to vaporize this agent in concentrations sufficient to produce deep anæsthesia and it may be that this is a good thing because of certain effects such as tachypnœa and cardiac arrythmia which may occur when attempts are made to provide such anæsthesia.

Cyclopropane is an anæsthetic gas which more than any other has threatened to replace the older agents. When properly administered it has a high co-efficient of safety, its toxicity being less than that of chloroform and ether and its flexibility of control much greater. Variations in depth of anæsthesia can be achieved rapidly with cyclopropane. Apart from its relative safeness during administration, cyclopropane compares more favourably with the others in respect to the incidence of respiratory,

circulatory and metabolic disturbance in the post-operative period. Like ether it is inflammable and explosible in certain concentrations with air and oxygen. That is a disadvantage which contra-indicates this gas when diathermy is employed in certain operations on the head and neck or within the thorax.

With this brief review of the volatile drugs in common use one must now consider to what extent the practice of anæsthetics has changed in the various clinics since the fairly recent introduction of the intravenous barbiturates and cyclopropane and what are the views expressed to-day in regard to the older agents, particularly ether. Some of these views are of an impressionistic character and not supported by adequate analytical evidence for or against the agents concerned. One reads, for instance, of the great quantities of ether that are used in certain hospitals. It would be interesting to know what such figures mean relative to the amounts used ten years ago and what quantities of the newer agents, cyclopropane and pentothal, are also employed. It may be of interest to note that in the hospital (1,200 beds) to which I am attached, 2,057 pounds of ether were used in the year 1936. A decade later (1946) the figure for the same hospital was 1,137 pounds. Corresponding to the large decrease in the amount of ether employed there was an increase in cyclopropane which for the year 1946 totalled 4,434 gallons. .

The annual reports of the Section of Anæsthetics of the Mayo Clinic` provide interesting commentaries on modern trends. For years a large proportion of the surgical work there has been performed under regional analgesia but general anæsthesia is also employed and its value carefully assessed. In the report for 1944 the following statement is made : " Ether is so valuable to the anæsthetist that in 1944 a determined effort was made to train all student anæsthetists in the department in the use of this agent by the open method." This is a commendation of ether with which the majority of anæsthetists in Britain would agree especially in regard to its application as a method of training students. The report for 1945 discusses the use of intravenous barbiturates: " It is advisable to limit amount of pentothal sodium to not more than 1·5 to 2 gm. Larger doses result in a relatively long period of restlessness such as followed the use of Sodium Amytal or Nembutal as intravenous anæsthetics. A short-acting barbiturate in overdose loses the advantages that it possesses when given in small or moderate doses." In this year also the report refers to a decrease in the use of regional analgesia, possibly due to substitution by dextrotubocurarine chloride and a more general adoption of the endotracheal technique. The opinion is expressed that curare plus cyclopropane or nitrous oxide and oxygen supplemented if necessary by a little ether may be used in abdominal surgery in preference to spinal analgesia when the patient is debilitated. " It is clear," the report states, " that patients given curare plus a gas with or without a small quantity of ether have less postoperative prostration and distress than those who are given considerable

quantities of ether." This comment is in keeping with the experience of many anæsthetists and is one with which an increasing number of surgical colleagues would agree.

The fact can hardly be denied that the true index of what an anæsthetist really considers best for the patient is what he chooses to administer in his personal cases, and Tables I and II are submitted in the belief that they illustrate the present trend in respect to the use of volatile anæsthetics.

In Table I, which covers a period of four years, it will be noted that cyclopropane has been the major agent chosen in a high proportion of cases. But for shortage of supply this gas would have been employed even more frequently. A large number of minor operations such as the enucleation of tonsils by the guillotine, extraction of teeth and uterine curettage accounts for the relatively high figures for ethyl chloride and thiopentone alone.

TABLE I

Anæsthetic Sequences in 5,117 Consecutive Cases
(Private Practice)

Induction Agent	Anæsthetic	Total
Thiopentone (1,170) or N_2O+O_2 (1,144)	Cyclopropane	2,314 (45·22%)
Thiopentone (175) or N_2O+O_2 (517) ..	Ether	692 (13·52%)
Thiopentone (7) or N_2O+O_2 (3) ..	Divinyl Ether	10 (0·19%)
N_2O+O_2 (644)	Ethyl Chloride	644 (12·58%),
Thiopentone (9) or N_2O+O_2 (2) ..	Chloroform	35 (0·68%)
Thiopentone (41)	N_2O+O_2	187 (3·65%)
Thiopentone (9) or N_2O+O_2 (4) ..	Trichlorethylene	13 (0·25%)
Thiopentone	Thiopentone	1,056 (20·64%)
	Regional (Spinal, &c.)	166 (3·24%)

The increasing use of cyclopropane and the diminishing use of ether are clearly shown in Table II. To a considerable extent the marked preponderance of the former in the years 1945 and 1946 is coincident with the introduction of dextro-tubocurarine chloride as an adjuvant.

In hospital practice the instruction of students must be given consideration and therefore ether, the most suitable anæsthetic for the purpose, cannot be replaced to the same extent as in private work.

TABLE II
FREQUENCY OF USE OF CYCLOPROPANE AND ETHER
(Private Practice)

Induction Agent	Anæsthetic	1943	1944	1945	1946
Thiopentone or N_2O+O_2	Cyclopropane (Closed Circuit)	33·06%	40·09%	48·93%	61·48%
Thiopentone or N_2O+O_2	Ether (Closed Circuit)	26·2%	17·63%	8·7%	2·91%

This modifying effect is reflected in Table III in which are given details of anæsthetics administered in a teaching unit.

TABLE III
UNIVERSITY SURGICAL UNIT—1947
ANÆSTHETIC SEQUENCES IN 1,829 CONSECUTIVE CASES

Induction Agent	Anæsthetic	Total
Thiopentone (520) or N_2O+O_2 (43) ..	Cyclopropane	563 (30·8%)
Thiopentone (442) or N_2O+O_2 (132) ..	Ether	574 (31·4%)
Thiopentone (4)	Chloroform	4 (0·27%)
Thiopentone (69) ; N_2O+O_2 (9) ..	N_2O+O_2	78 (4·26%)-
Thiopentone (27) ; N_2O+O_2 (2) ..	Trichlorethylene	29 (1·58%)
Thiopentone	Thiopentone	322 (17·6%)
	Regional (Spinal, Caudal, &c.)	259 (14·16%)

In the 1947 hospital series cyclopropane and ether have been employed with about equal frequency but a comparison in respect to the use of these two agents in the same unit in 1937 (Table IV) shows the extent of the decline of ether.

It would be unfair to generalise from the limited data submitted because other hospitals and anæsthetists might produce figures to confound the inferences that have been made. Nevertheless, one feels bound to recognize the evolution that is going on and state one's belief that the new century of anæsthesia just beginning will witness the passing of general anæsthesia in the form in which it has been largely accepted and practised during the

past hundred years. In the present period of transition, general anæsthesia, particularly of the inhalational type, is still the technique most frequently employed. This, however, is due less to its intrinsic merits than to a paucity of proficient exponents of combined methods·in which the production of unconsciousness plays a lesser part than formerly and is truly subsidiary to less toxic methods of ensuring analgesia and muscular relaxation.

TABLE IV

FREQUENCY OF USE OF CYCLOPROPANE AND ETHER

Induction Agent	Anæsthetic	1937	1947
Thiopentone or N_2O+O_2	Cyclopropane	3·1%	30·8%
Thiopentone or N_2O+O_2	Ether	63·5%	31·4%
Other Agents and Methods		33·4%	37·8%

THE APPLIED ANATOMY OF THE GALL-BLADDER AND EXTRA-HEPATIC BILIARY PASSAGES, WITH SPECIAL REFERENCE TO THEIR DEVELOPMENT

Embryology

THE 4.5 MM. HUMAN EMBRYO (4th to 5th week) shows an entodermal bud growing from the distal end of the foregut into its ventral mesentery. This is the hepatic bud whose branching stem produces the liver with its intra- and extra-hepatic duct system, including the gall-bladder.

Only that portion of the gut which is supplied by the cœliac axis artery —the foregut—possesses a ventral mesentery. This is attached to the anterior abdominal wall as far as the umbilicus. Cranialwards it broadens out and thickens to become the septum transversum which at this stage partially separates the thoracic and abdominal cavities. Caudalwards it ends abruptly on the gut at a point which later will be recognized as the junction of the upper ⅔ with the lower ⅓ of the second part of the duodenum. Here the hepatic bud first forms and determines the site of the future duodenal papilla and ostium of the common bile duct and main pancreatic duct.

Embedded in the ventral mesentery the hepatic bud as it grows extends upwards and penetrates the septum in the interior of which its terminal branches produce innumerable rods of cells (hepatic cylinders) which after canalisation become the intra-hepatic biliary ducts and canaliculi. The entodermal cells in the walls of these minute channels become the glandular cells of the liver, and the mesoderm of the mesentery and septum transversum forms the connective tissue of the whole hepatic system.

From the base of the bud, close to the gut, two secondary buds arise in a lateral position, right and left—the ventral pancreatic buds. In man the left of these quickly degenerates and disappears, but the, right one grows rapidly and produces the lower part of the head of the pancreas (uncinate lobe) and the terminal portion of the main pancreatic duct (Wirsung) whose opening into the duodenum, therefore, will inevitably be closely associated with the opening of the common duct on the duodenal papilla. The main hepatic stem continues to lengthen and on its

right side produces a branch which, without further division, ends in a blind diverticulum—the gall-bladder—whose stalk becomes the cystic duct. More distally the parent stem again sprouts, this time dichotomously, to form the right and left hepatic ducts. These continue the branching process and eventually form the intra-hepatic biliary duct system and the liver itself.

In the light of the foregoing elementary facts regarding the development of the biliary tree it will not be surprising to find that certain anomalies, due to exuberant or aberrant growth, are quite common, and that others of a rarer type occasionally present themselves to the surgeon.

Anomalies of the Biliary Tree

The gall-bladder may not remain as a blind cul-de-sac but may itself sprout like the other terminal parts of the tree and thus produce accessory ductules which communicate directly between it and the liver.

Two gall-bladders may form on the biliary stem, each connected to the common bile duct by its own cystic duct (vesica duplex) or sharing the same cystic stalk (vesica divisa). A much commoner anomaly is the presence of an accessory hepatic duct usually coming from the right extremity of the porta hepatis and uniting with the common hepatic duct at a point more distal than the junction of the other two. Such a duct, when present, inevitably has a close relation to a normally situated cystic artery lying, as it does, in the angle between the cystic and common hepatic ducts.

Commonest of all are the variations in the length of the ducts themselves. The two hepatic ducts are usually short and lie high up in the porta hepatis. They may, however, extend much lower before uniting, thus shortening the length of the common hepatic duct. The cystic duct may be only a few mm. in length or it may be absent altogether, leaving the gall-bladder as a sessile diverticulum on the common duct stem. The gall-bladder itself may be absent as is the case in many animals, e.g., the rat, the pigeon, and the horse. On the other hand, a normally formed gall-bladder may be enveloped and buried in the liver substance, just as the inferior vena cava and the umbilical vein are sometimes found to have been embedded by the exuberant growth of the surrounding hepatic tissue. The cystic duct may extend far down, running close and parallel to the main duct for several inches, before opening into the latter close to the duodenal wall. In such circumstances the two ducts are often enclosed in a common fascial sheath.

If an apparently normal junction of the cystic and common duct is slit open, an internal partition is frequently found separating them for a considerable distance beyond their point of meeting, the common duct here possessing a double lumen. The importance of this to the surgeon is obvious, e.g., in division of the common duct followed by cholecystenterostomy.

It will be remembered that the cystic duct itself possesses a permanent internal spiral fold of its mucous membrane (valve of Heister) which prevents kinking of the duct in spite of its S-shaped bends, and thus no doubt, facilitates the flow of bile up or down the tube according to need. The ridge extending distalwards from the junction of the cystic and common ducts, above described, has probably a similar functional value.

On the inferior part of the neck of the gall-bladder there is frequently an accessory diverticulum (Hartmann's pouch) which is of special interest since in inflammatory conditions it is one of the first parts of the viscus to form adhesions to neighbouring structures, particularly the first part of the duodenum.

The cystic duct instead of coming from the right side of the main tube may sprout from its anterior wall or from its left side, in which case it crosses the common duct to reach the gall-bladder—a circumstance again of great import to the surgeon.

A Critical Point in the Duodenum

The site of outgrowth of the primary hepatic bud is obviously a critical point in the anatomy, physiology and pathology of the duodenum.

From about the 5th to the 6th week the rapid proliferation of the entodermal epithelium in the biliary stem as well as in the duodenum itself, causes, quite normally, a temporary occlusion of the gut (Keith[1]).

After the 6th week the expansion of the tube and the absorption of the excess of its entodermal lining restores the lumen. Sometimes resolution fails to take place and atresia duodeni, partial or complete, is the result. Fig. 1 shows a case of this type in which, at birth, a stenosis of the duodenum existed exactly at the point where the common bile duct penetrated the gut wall. In severe cases the atresia may extend to the gall-bladder and the hepatic duct system.

Blood Supply

The blood supply of the biliary tract is notoriously variable but when it is remembered that the hepatic bud arises from the gut on the boundary line between the foregut (supplied by the cœliac axis) and the midgut (supplied by the superior mesenteric artery), it is not surprising that the main artery of the liver sometimes comes from the one and sometimes from the other of these vessels, and not infrequently there are two hepatic arteries, one coming from each source. Nor is it to be wondered at that the superior pancreatico-duodenal branch of the cœliac axis tree anastomoses with the inferior pancreatico-duodenal branch of the superior mesenteric artery in the region of the duodenal papilla. The pancreatico-duodenal arteries are often duplicated.

It is the cystic artery itself, however, which is, perhaps, of greatest importance to the surgeon. You will remember that it is usually given

off by the right branch of the hepatic artery just after the latter has crossed from left to right behind the common hepatic duct and in front of the portal vein. Not infrequently, however, the parent stem, or the cystic artery itself, crosses anterior to the duct, and in rare cases (9 per cent.) (Grant[2]) it may be found running deeply and crossing behind the portal vein. In all these cases, however, the cystic artery finally comes to lie above and to the left of the cystic duct in the cleft between it and the common hepatic duct, and running to the neck of the gall-bladder it divides into two branches, one taking a course beneath the peritoneum of its free surface and the other taking the side apposed to the liver. An accessory cystic artery is occasionally present. This may ascend from the main hepatic vessel or even from the superior mesenteric artery. An accessory hepatic artery arising from the left gastric artery is quite common. The cystic vein as a rule drains into the right branch of the portal vein in the porta hepatis, but one or more small veins may pass direct to the liver from the upper surface of the gall-bladder, thus accounting for the venous bleeding which sometimes occurs when the gall-bladder is separated from its hepatic bed.

Peritoneal Folds

At an early period the duodenum and its two mesenteries (with their contained structures) lie in the sagittal plane, but the " rotation of the gut," and all that this involves, profoundly alters the anatomy of the upper abdomen. This is not the occasion to describe these processes in detail. Suffice it to recall that the end-result, as far as the duodenum is concerned, is to lay it over on its right side and to plaster it down in this position so that it and its mesenteries adhere to the structures on the posterior abdominal wall, e.g., the right kidney, the renal vessels and the inferior vena cava. This rotation movement, combined with a differential growth of its wall which causes an unequal expansion of the duodenal tube brings the original anterior wall and the site of the duodenal papilla to a posterior position. The ventral mesentery containing the biliary stem likewise becomes folded over with the gut so that the common bile duct comes to occupy a position dorsal to the head of the pancreas and the first part of the duodenum. The latter portion of the gut, like the pylorus, retains a considerable amount of mobility because its ventral mesentery still has an unattached border—the free border of the lesser omentum. Above, this mesenteric fold encloses the porta hepatis and, extending to the right and forwards, enfolds the gall-bladder. Extending to the left and backwards it becomes continuous with the attachment of the gastro-hepatic ligament in the fissure which contains the ligamentum venosum.

Between the liver and the duodenum it forms the anterior wall of the epiploic foramen (of Winslow) containing the common bile duct and the cystic duct, the hepatic artery and the portal vein. Remembering the relation of the hepatic bud and its derivatives to the ventral mesentery

and the amount of rotation and enfolding to which this mass of plastic mesoderm has been subjected, it is not surprising that the definite attachments of the duodeno-hepatic fold are liable to some variation. This is the explanation of those frequent extensions of the lesser omentum to the right, attaching the inferior surface of the gall-bladder to the second part of the duodenum and transverse colon, or even reaching far enough completely to enfold the fundus of the gall-bladder and attach it to the right colic flexure (cystico-colic ligament). Some such outlying part of the lesser omentum, in greater or less degree, is very common. It is a bloodless fold because the biliary ducts and their accompanying vessels remain in their normal position. The clinical importance of such a ligament, however, lies in the fact that it forms a focus for adhesions binding gall-bladder to duodenum or transverse colon, thus permitting gallstones to ulcerate through into one or other of these viscera.

The green discoloration of the pyloric canal sometimes seen at autopsy is due to the fact that the gall-bladder not infrequently lies in close relation with it. Adhesions may develop between the gall-bladder and the pyloric canal, and gallstones may ulcerate through into the stomach and be vomited (Wingate Todd[3]). In this connection it is well to remember, too, the close relationship of the fundus of the gall-bladder to the anterior abdominal wall. Treves and others have reported cases where gallstones have suppurated out through the anterior abdominal wall, and have been removed from abscesses in the parietes[4].

It will be obvious that in the operation of mobilizing the duodenum to gain access to the lower part of the common bile duct, the surgeon is actually restoring the duodenum to its original embryonic position.

Microscopic Anatomy

A striking feature of the structure of the biliary tract, as a whole, is the relative absence of muscle as compared with the intestinal tube. Our investigations confirm the observations of Boyden[5] and others that the biliary ducts are, for the most part, fibro-elastic tubes capable of great distension but non-contractile, except in the case of the gall-bladder and the lower one inch of the common bile duct in which smooth muscle is plentiful. This is nothing new, however, for some 90 years ago Köllicker[6] described the wall of the ductus choledochus and cystic duct as " distinctly divided into a mucous membrane and a fibrous layer, which latter contains a few muscular fibre-cells, though, upon the whole, so sparingly, that these ducts cannot be said to possess a special muscular coat."

The muscle of the gall-bladder is not arranged in layers as in the intestine, but is composed of interwoven fibre bundles. Its mucous membrane is lined with high columnar epithelium and though there are no villi in the accepted sense of the term, the membrane is thrown up into a series of irregular ridges which give the inner surface of the mucosa a flattened
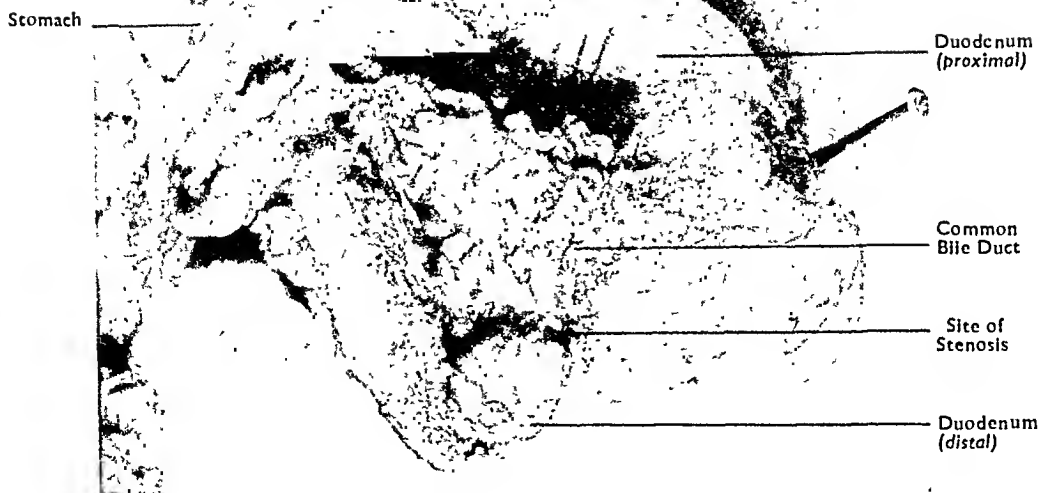
Fig. 1. Congenital atresia of duodenum, showing site of stenosis where common bile duct penetrates the gut wall.

Fig. 2. Duodenum, human embryo, 27 mm. Transverse section ×62. Note common bile duct embedded in developing pancreatic tissue external to the gut wall.
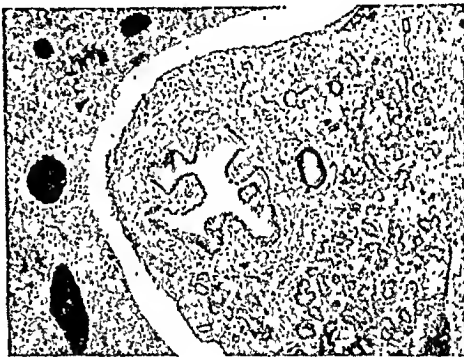
Fig. 3. Duodenum, human embryo, 27 mm. Transverse section ×62. Note common bile duct entering muscle coat of gut.

By kind permission of The Editor, Journal of Anatomy.
Fig. 4. Duodenum, human embryo, 27 mm. Transverse section ×50. Note common bile and pancreatic ducts in submucosa surrounded by differentiating muscle continuous with muscle of duodenal wall.
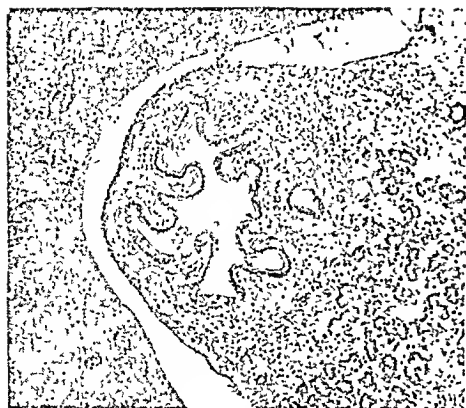
Fig. 5 Duodenum, human embryo, 27 mm. Transverse section ×62. Common bile and pancreatic ducts have now joined Note the surrounding muscle.

Fig. 6. Duodenal papilla and ostium of human adult Longitudinal section ×14.

Fig. 7. Duodenal papilla of human adult. Transverse section ×15. Common and pancreatic ducts lying in submucous coat of bowel approaching ostium.

Fig. 8. Duodenal papilla of human adult, ×2. Note typical arrangement of plicæ of mucous membrane, also presence of the valvular plug in the orifice.

honeycomb appearance. This greatly increases the surface area which is so much concerned with the absorption of bile fluid. While in the gall-bladder the concentration of the bile is such that it takes approximately 500 c.c. of bile from the liver to produce 50 c.c. of bile in the common duct. About 1,000 c.c. are secreted by the liver every 24 hours, and the normal capacity of the gall-bladder is 50 c.c. (approximately $1\frac{1}{2}$ ounces). Bile begins to be secreted by the liver at the end of the twelfth week (Lucas Keene and Hewer[7]). Large numbers of elastic fibres are mixed with the collagen fibres of its outer coat and, under certain pathological conditions, the distensibility of the gall-bladder is quite remarkable, e.g., mucocele and empyema. The biliary ducts themselves are lined by columnar epithelium of a similar type and the lamina propria of fibro-elastic tissue is studded with many mucos-secreting tubulo-alveolar glands. These are typical of the whole biliary tract with the exception of the gall bladder in which, however, they are sometimes to be found near its neck.

The terminal end of the common bile duct penetrates the wall of the duodenum and united with, or in close proximity to, the main pancreatic duct, opens on a papilla $3\frac{1}{2}$ to 4 inches from the pylorus. As the duct pierces the muscle coats of the duodenum it splits the two layers of muscle in grid-iron fashion, and, as it does so, first the longitudinal coat and then the circular coat contribute to form a muscular collar which surrounds both the extra-mural and intra-mural portions of the duct. The duct pierces the wall of the gut obliquely and comes to lie with the pancreatic duct in the sub-mucous coat of the bowel where they are now both surrounded by the muscular collar (sphincter of Oddi). As they lie in juxtaposition muscle bundles not only surround but pass between the two ducts. The extra-mural part of the sphincter is derived from the longitudinal coat and the intra-mural portion is continuous with the circular fibres of the gut. In the region of the muscular " window " the circular coat of the duodenum is markedly thickened and the amount of nerve tissue in Auerbach's plexus is noticeably increased. This development of a sphincter muscle around the ducts as they lie in the sub-mucous coat can be plainly seen in the human embryo of 27 mm. (8 weeks) as also can its derivation from the muscle of the duodenal wall even at this early stage. (*Vide* Figs. 2, 3, 4, and 5.) The so-called ampulla of Vater, i.e., a dilated channel common to the bile and pancreatic ducts, seems to be a misnomer, for it is not to be found in most human subjects. Figs. 6 and 7 show the usual mode of termination in the adult. As the united ducts pass to their opening on the duodenal papilla, the channel is packed with valvular folds of its mucous membrane and muscle fibres extend into the connective tissue core of these folds. Such an arrangement suggests that contraction of the sphincter muscle has the additional effect of retracting and bunching these folds together, thus preventing reflux of duodenal contents as well as controlling the exit of bile into the bowel.

No muscle is found surrounding the actual orifice itself and often even with the naked eye the tip of the valvular plug can be seen occupying the aperture (Fig. 8).

Large nerve bundles (nervus choledochus) accompany the common bile duct throughout its length and nerve fibre endings can be traced in the smooth muscle of the sphincter as well as in the muscle fibres of the valvular folds.

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THE APPLIED ANATOMY AND PHYSIOLOGY OF THE PHARYNX AND ŒSOPHAGUS

by

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THE SURGEON APPLIES his knowledge of anatomy and physiology when he examines a patient to make a diagnosis, and whenever he carries out treatment in the form of a manipulation or an operation. It is from this point of view that I wish to approach the subject of the applied anatomy and physiology of the Pharynx and Œsophagus.

The Function of the Tonsil

" What is the function of the tonsil?" has been frequently asked. The tonsil is a specialised lymphatic gland and owing to its exposed position in the mouth it is susceptible to infections. The tonsil has the structure of a lymphatic gland and behaves like a lymphatic gland. Tonsillitis is an adenitis which is primary and secondary. Primary tonsillitis arises from a direct infection from one patient to another or from polluted milk, water or food. It is sometimes part of a general intestinal infection, or of measles and scarlet fever, particularly in children. A general infection is often localized to the tonsils. Secondary tonsillitis arises from the sepsis after teeth extraction, particularly those of the mandible, also from sepsis following an operation on the nose or even from sinusitis, or any septic focus in the nose or throat. There is no evidence to show that the tonsil or lymphatic glands have a secretion and the theory of an internal secretion has been abandoned. When the tonsils have been removed, the lymphatic tissue of the pharynx and the lymphatic glands of the neck take on its function.

The operation of enucleation requires a knowledge of the blood supply of the tonsil. The descending palatine artery embraces the upper pole of the tonsil and it can be seen when the upper pole is evulsed from the palate. The artery or one of its branches lies between the upper pole of the tonsil and the posterior pillar of the fauces. The ascending pharyngeal artery pierces the superior constrictor muscle to reach the tonsil about its middle and under cover of the anterior pillar of the fauces. It is seen and clipped with forceps when the tonsil is pulled away from the anterior pillar. The dorsalis linguæ artery passes from the base of the tongue to the lower pole of the tonsil. This artery spurts when the tonsil is separated from the base of the tongue. There is a small plexus of veins lying on the surface of the superior constrictor muscle deep to the tonsil and injury

to one of these veins is a frequent source of hæmorrhage after enucleation. This injury is avoided by hugging or keeping close to the capsule of the tonsil and swabbing it away from its bed. A secondary hæmorrhage about the sixth day after enucleation may arise from an erosion of one of these veins as the result of sepsis. The carotid arteries in their normal position are nearly half an inch away from the tonsil and separated from it by the superior constrictor muscle, but the internal carotid artery is nearest to the pharyngeal wall and sometimes takes a syphon bend inwards to lie immediately behind the pharyngeal wall and the posterior pillar of the fauces in close relation to the tonsil. The pulsation can be seen and felt in this position. *Erosion of a carotid artery* or of the internal jugular vein has arisen from cellulitis or from a retropharyngeal abscess situated behind the posterior pillar and arising from the tonsil. This pharyngeal or peritonsillar abscess has resulted in a severe fulminating hæmorrhage and Salinger and Pearlman have collected the records of 227 cases of which 81 occurred in children, 30 cases arose from scarlet fever in which the jugular vein was involved. A lateral retropharyngeal abscess is more common in children and owing to trismus may escape detection until it has spread to the carotid sheath. These children are admitted to hospital with the history of a sore throat and a severe hæmorrhage and unfortunately it has been followed by a fatal fulminating hæmorrhage, often occurring at night.

Fig. 1.—This photograph of a specimen from the museum of the Ferens Institute shows an erosion of the internal carotid artery immediately above the bifurcation of the common carotid. This erosion is in a cavity full of blood clot with a thrombosed vein embedded in it. The walls of the cavity are brawny and cut like an unripe pear. A section for microscopy showed inflammatory tissue and no new growth. There was a similar specimen with erosion of the internal jugular vein. The patient, a woman aged 36, was admitted to hospital with a hard brawny swelling of the right side of the neck of four days' duration following tonsillitis which had commenced a month ago. Some blood expectorated, T. 100·2 P. 138. A rounded swelling of the right side of the pharynx extending into the right pyriform fossa could be seen with the laryngoscope. On the night of admission a sudden copious hæmorrhage from the throat recurred and the patient died before assistance arrived. There were two sinuses in the pharyngeal wall through which the blood escaped into the pharynx. The specimen was very similar to the photograph and the history is typical of the erosion of one of the vessels of the carotid sheath. A dusky blood red pharyngeal abscess rapidly increasing in size with a marked swelling in the neck and an initial warning hæmorrhage or leak demands an immediate ligature of the eroded vessel if the patient's life is to be saved. The commonest erosion is that of the internal carotid artery near the bifurcation of the common carotid. The internal jugular vein has been eroded near the same site. The venous hæmorrhage from the jugular vein can be controlled temporarily by pressure.

Fig. 1

Erosion of left internal carotid artery at bifurcation of common carotid.

There is no case in surgery which needs such an accurate diagnosis and such prompt treatment. Some of these patients have died on the way to the operating theatre. As soon as the patient arrives in the theatre, a blood transfusion and pentothal should be administered. It is advisable to expose and ligature the common carotid artery because it is impractical to ligature either the internal or external carotid below the erosion. The common carotid was ligatured in 54 cases and 36 recovered. At the same time the jugular vein is carefully examined and ligatured if thrombosed or eroded. Thrombosis of the internal jugular vein has been known to arise from a very acute tonsillitis. At a post mortem a quantity of blood was found in both lungs as well as in the stomach. This is an indication to apply the suction tube to both bronchi through the direct laryngoscope or the bronchoscope as soon as the common carotid has been ligatured. Erosion of the internal jugular vein and of the external carotid has arisen from a glandular abscess in the neck. I have seen one case of erosion of the external carotid artery following the implantation of radium into the neck for cancer. Of the 227 cases of hæmorrhage due to the above causes 168 died.

The incision of a peritonsillar abscess situated in the palate has been known to be followed by an alarming and continued hæmorrhage. This is probably due to the erosion of the descending palatine or ascending pharyngeal artery. The tonsil has been enucleated and the bleeding vessel secured with a successful result. Both types of cases require prompt operative treatment and any hesitation may prove fatal.

Readers will be familiar with the anatomy of the *Pharyngeal Diverticulum* (Fig. 2) or Propulsion Pouch. It is a hernia of the pharyngeal mucous membrane through a weakness of the wall of the pharynx between the circular and oblique fibres of the inferior constrictor muscle. The circular fibres known as the crico-pharyngeus muscle is the upper sphincter of the œsophagus and is always closed except for the passage of food. It prevents air passing into the stomach with each inspiration.

The oblique fibres of the inferior constrictor muscle (Fig. 3) help to draw the larynx upwards against the base of the tongue during swallowing. The lumen of a pharyngeal pouch is in a direct line with that of the pharynx and its posterior wall. Food and the œsophagoscope tend to pass straight into the pouch. The opening of the upper sphincter of the œsophagus is puckered and slit-like and not easily seen lying in front and immediately behind the cricoid plate. There is a steep and sharp septum between the pouch and the œsophagus and it is similar but more marked than the carina of the bifurcation of the trachea. This septum appears to cover the orifice of the œsophagus. Some years ago Chevalier Jackson punched away this septum through an endoscope but this operation was soon abandoned as unsatisfactory. Food passes more easily into the pouch than through the narrower orifice of the œsophagus.

Fig. 2
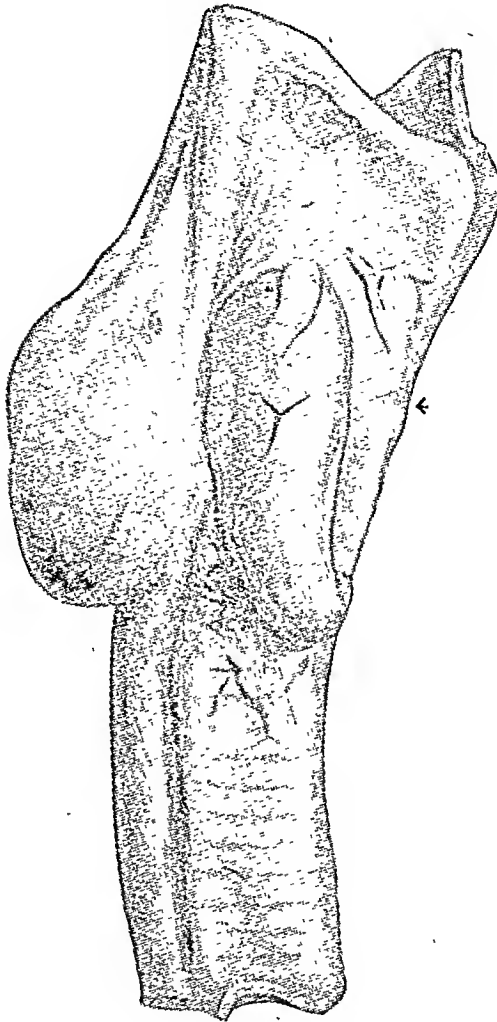Pharyngeal diverticulum (Specimen No. 1523 B. University College Hospital Museum).
The arrow indicates upper border of cricoid cartilage. ($\frac{3}{4}$ natural size.)

Oblique Fibres of
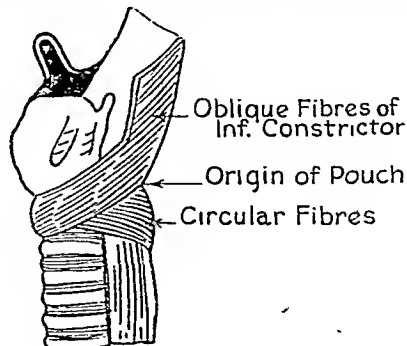Inf. Constrictor

Origin of Pouch

Circular Fibres

Fig. 3
Drawing of fibres of inferior constrictor muscle to indicate origin of pharyngeal
diverticula. (Sir A. Keith. *Brit. Med. Journal.*, 1910, Vol. 1. p. 376.)

The filling of the pouch by food and the increased pressure resulting from the effort to swallow produces a steady increase in the size of the pouch. This steady increase is just like that of a hernia. The full pouch not only presses on the œsophagus, but by traction distorts the lumen and causes dysphagia. When this occurs the patient empties the pouch by pressure on the left side of the neck and returns a bolus of food into his mouth which he again swallows. When the pouch contains air a characteristic gurgling sound is produced by swallowing or by pressure from the outside. The time arrives when the patient loses weight and strength owing to insufficient food reaching the stomach and an operation becomes imperative. A number of operations have been designed for the cure of the pouch or hernia but the two operations most efficient are :

Firstly, excision of the pouch and the complete closure of the resulting fistula of the pharynx by three or more layers of careful stitching at the one operation. It is similar to a radical cure for hernia.

Secondly, what is known as the two stage operation in which the pouch is freed and drawn outwards and upwards, then stitched to the edges of the wound. At a second operation a week or so later the pouch is excised. The fistula and wound is closed by careful stitching. The pouch has been known to slough away or slip back into the neck. It is claimed that the two-stage operation is safer and that the dreaded leak and septic mediastinitis does not occur. In my own experience recurrence is more common after the two-stage operation.

The following are the steps of the single operation of excision carried out by the late Mr. Trotter, from notes I made at one of his operations, which were invariably successful :

1. Vertical incision just *behind* the anterior border of the sterno-mastoid from the angle of the jaw to the sternum.
2. Anterior half of sterno-mastoid divided just above its insertion into the sternum to attain good access and exposure.
3. Lateral lobe of thyroid freed and retracted inwards. Superior thyroid artery divided.
4. Pouch identified by pulling thyroid ala forwards and away. Pouch carefully dissected with forceps and drawn outwards.
5. Feeding tube passed into the gullet by the mouth.
6. The position of the pouch accurately shown protruding between the oblique and circular fibres of the inferior constrictor muscle. A large pouch looking almost sessile. The wound packed from the mediastinum with gauze.
7. The outer layer of pouch consisting of muscle and fibrous tissue divided about $\frac{1}{2}$ inch from its attachment to the œsophagus dissected inwards to form a cuff to cover the stump left by the excision of the pouch. The mucous membrane of the pouch dissected free without perforation.

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8. When the mucous membrane of the pouch was dissected free it became pedunculated.

9. A purse string retaining stitch inserted at extreme edge of this peduncle and the mucous membrane snipped and a stitch inserted with each snip, and it was then seen that the orifice into the gullet was constricted. The mucosa was thus securely stitched and a second layer of Lembert sutures inserted. The redundant cuff of the fibro-muscular layer was then trimmed and securely stitched by two layers of sutures.

The cut end of the sterno-mastoid was stitched to the prevertebral fascia to support the wall of the pharynx. A large drainage tube inserted in the lower end of the wound, the wound filled with powdered boracic and closed. The feeding tube is retained for a week if possible. Sir Thomas Dunhill has performed a similar operation with the exception that he prefers a collar skin incision such as is used for a thyroidectomy instead of the vertical sterno-mastoid incision employed by Trotter.

ŒSOPHAGOSCOPY

A knowledge of the curves of the *Vertebral Column* and of the method of straightening them is essential for a successful œsophagoscopy. The flexible cervical vertebræ are slightly convex and it is necessary to flatten this curve so as to pass the œsophagoscope through the thoracic inlet to negotiate the deep concavity of the thoracic vertebræ. This concavity rises to a convexity at the junction of the thoracic and lumbar vertebræ. The majority of œsophagoscopists prefer to have their patients lying flat on their backs in the dorsal position. It appears to be the only satisfactory position when the patient is given a general anæsthetic. The head and neck are supported well over the end of the table either by a Negus adjustable support or by an assistant. It is essential to be able to flex or extend the head and shoulders and to straighten the vertebral column as far as possible at the desired moment.

The œsophagoscope is introduced into the mouth at an oblique angle when the head is horizontal with the tongue and mandible drawn forward. As the œsophagoscope passes into the pharynx the head is lowered and the neck extended slightly with the mandible well forward. When the epiglottis and the orifice of the larynx are seen the head is raised or flexed and the œsophagoscope passes into the right pyriform fossa. Sometimes the internal laryngeal nerve, if you look for it, can be seen deep to the mucosa crossing the pyriform fossa to reach the aryteno-epiglottidean fold and larynx. This nerve is anæsthetized on both sides by swabbing the surface with a loaded wool carrier dipped in a solution of 10 per cent. cocaine and adrenalin. The œsophagoscope is then brought into the midline and a good view of the upper sphincter of the œsophagus at about 15 cm. from the teeth must be obtained. By a careful wriggling movement the sphincter is passed, then air dilates the œsophagus which appears as a

the gullet into the stomach. If the patient holds his breath immediately after swallowing, the bolus is held up at the hiatus of the diaphragm momentarily. The diaphragm is then in the lower position or that of inspiration and when the diaphragm rises with expiration the bolus passes into the stomach. The bolus is held up at the level of the diaphragm and not at the cardia which is the junction of the œsophagus and stomach. When the patient is lying down or in the Trendelenburg position the passage of the bolus through the thoracic œsophagus is slower and it is slow enough to take a photograph of the barium filling the gullet. There is no peristalsis, as so far as can be ascertained any change of air pressure in the pharynx or gullet has no material effect on the bolus, though the bolus is sometimes mixed with air.

In some aged patients the muscular action of the tongue appears to be feeble and some barium may collect in the vallecula. Other patients can hold up the barium voluntarily at the cricoid or upper sphincter. During vomiting the stomach contracts vigorously and a column of barium from the stomach oscillates up and down in the lower gullet, then an explosive and forcible contraction of the stomach shoots the barium through the relaxed gullet, pharynx and mouth. This oscillation of the barium bolus is like a golfer swinging his club immediately before driving the ball. I find that the cinematograph films do not show the movement of the diaphragm or of the epiglottis clearly, and a slower motion film is required.

X-ray, Normal Swallow (Fig. 4).

The X-ray photographs taken of a barium swallow shows the hiatal constriction to be lower than it is normally and at what appears to be the level of the cardia. There is a considerable variation in the pictures which are modified by the position of the patient, the film and the X-ray tube.

There has been considerable discussion on the part played by the epiglottis in the mechanism of swallowing. The function of the epiglottis is to direct air through the nose to stimulate the sense of smell. It is well developed in animals who depend on the sense of smell and poorly developed in human beings who make use of the mouth and lips in speech. Direct observation of the epiglottis during swallowing shows that it is pressed against the base of the tongue as it drops backwards and downwards to meet and overlap the rising larynx. I believe it will be accepted that the closure of the orifice of the stomach occurs at the hiatus or where the œsophagus passes through the diaphragm. The pathology of achalasia or cardiospasm is incomplete and failure of the hiatal œsophagus to relax during swallowing is an insufficient cause. A congenital neuromuscular inco-ordination is more probable.

The Relations of the Œsophagus

The importance of the relation of the surrounding structures to the œsophagus has increased considerably with the development of the operation for the trans-thoracic excision of growths of the œsophagus.
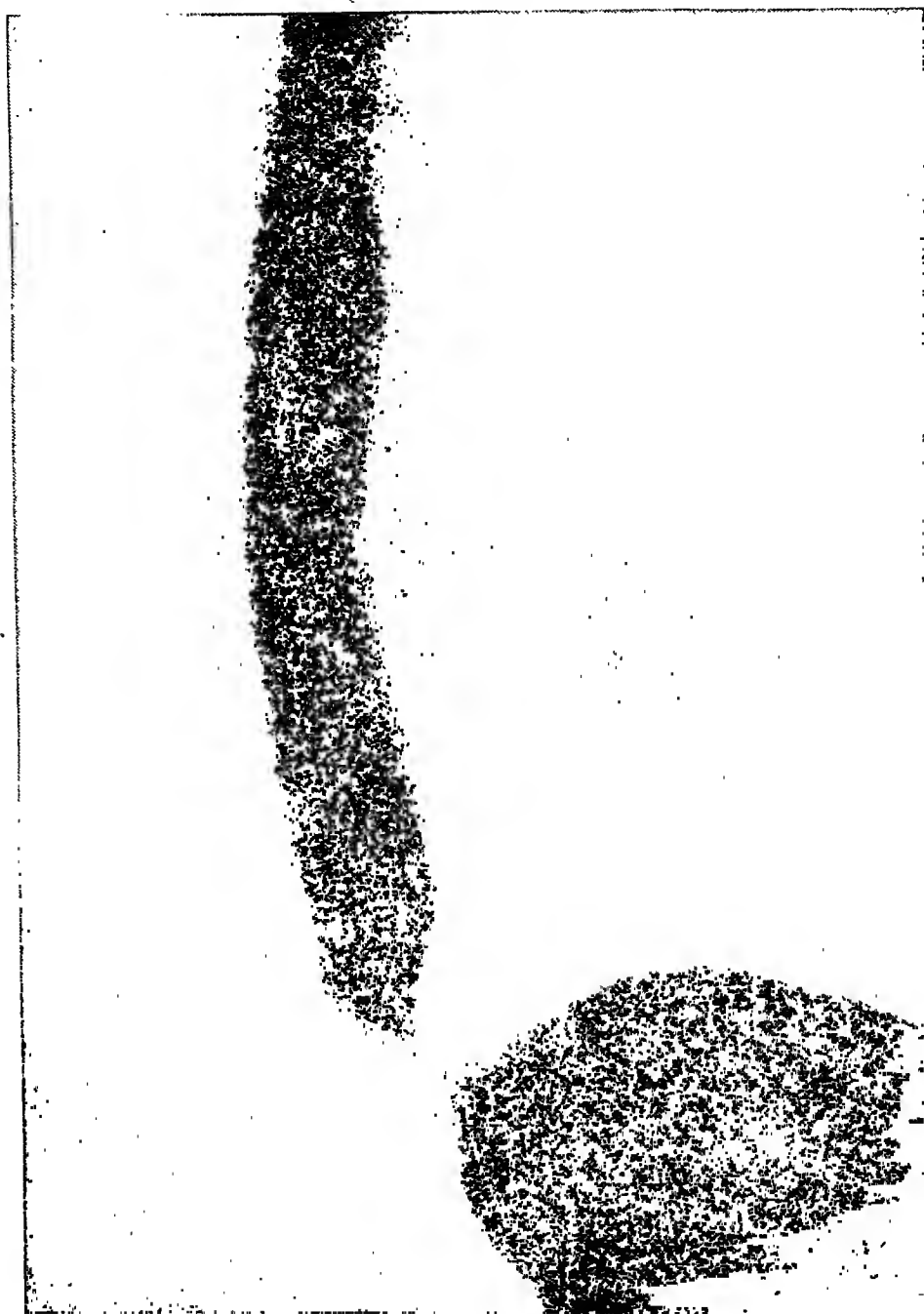
Fig. 4.

X-ray of normal barium swallow.

The relation of the aorta to the œsophagus is clearly shown in the drawing of the approach to the œsophagus through the left side of the chest. Carcinoma of the œsophagus is situated in a large number of cases just below the arch of the aorta and near the crossing of the left bronchus, and in others lower down and especially at the cardiac end. If the growth is well below the arch of the aorta, it is approached by a large incision, 12 inches in length, through the left sixth intercostal space and the ribs are forcibly separated by a rib spreader. Excision of a rib or ribs may be unnecessary. Souttar has pointed out that a growth above or immediately below the arch of the aorta or the usual congenital atresia of the œso-phagus is more easily approached from the right side. The presence of the arch of the aorta on the left side makes the exposure of the higher growths more difficult if the left side approach is made. On the other hand the growths of the lower end of the œsophagus and cardia are more easily approached from the left side. When the œsophagus is approached from the right side the formidable major azygos vein which crosses the œsophagus to join the posterior aspect of the superior vena cava has to be ligatured and divided to expose and free the œsophagus. Ligature of this large vein does not embarrass or have any appreciable effect on the patient. There is a free anastomosis with the vena hemiazygos and finally the left intercostal vein which joins the left innominate vein. Injury to the azygos vein is very embarrassing and a grave accident. Carcinoma is common in the cervical œsophagus but not between the thoracic inlet and the arch of the aorta. Aneurisms of the aorta used to frighten œsophago-scopists but they now appear to be more rare. It is the sacular aneurysm near the junction of the left subclavian artery and the arch of the aorta which ruptures into the œsophagus. There are a number of specimens of such cases in the museums of the London teaching hospitals. The relation of the phrenic nerve as it lies deep to the mediastinal pleura and runs from the pericardium to the diaphragm is observed because injection of this nerve with novocain produces temporarily a relaxed motionless diaphragm which facilitates manipulation and also diminishes shock. The relation of the left vagus nerve lying in front of the œsophagus and the right vagus behind are noticed. The left phrenic nerve crosses the arch of the aorta near the vagus but it lies to the outer side of the vagus.

The recurrent or inferior laryngeal nerves are in close relation to the upper œsophagus and the pharynx from the arch of the aorta on the left and from the subclavian artery on the right. These nerves are accom-panied by a chain of lymphatic glands. A paralysis of the left recurrent nerve and more rarely the right, accompanied by dysphagia indicates a growth of the œsophagus about or above the arch of the aorta or of the lower pharynx. It also indicates that the growth has progressed beyond successful excision. The metastatic growths in the lymphatic glands may have distorted or stretched the nerve or the growth may have infiltrated

it. In such a case the supra clavicular glands are frequently enlarged. It must be remembered that a malignant growth of the thyroid causes a recurrent laryngeal paralysis and dysphagia simulating a growth of the cervical œsophagus or the thyroid may be invaded by a secondary or metastatic growth. A growth of the cervical œsophagus produces a paralysis of the recurrent laryngeal nerve on the one side which is followed by a paralysis of the laryngeal nerve on the other side. Fortunately, both vocal cords take up the cadaveric position and tracheotomy is not urgent. A progressive dysphagia followed by a paralysis of the recurrent laryngeal nerve, first on one side and then on the other, is typical of a malignant growth of the cervical œsophagus.

The satisfactory reconstruction of the œsophagus after excision is a difficult problem. The stomach is freed and brought up into the thorax through the hiatus or the œsophageal canal of the diaphragm which is enlarged ; the stomach is placed in the groove left by the excised œsophagus and firmly anchored by stitches to the wall of the thorax. The lower end of the divided œsophagus is carefully anastomosed to the fundus of the stomach. This anastomosis should be absolutely devoid of tension as both the muscular and mucous membrane coats of the œsophagus are friable and stitches cut out easily. A leak of this anastomosis is a frequent cause of a fatal sepsis. The success of this improved operation depends very much on the *earliest possible diagnosis* and on the situation of the growth ascertained by a meticulously careful X-ray examination and by the œsophagoscope and bronchoscope. An epithelioma of the middle third of the œsophagus diagnosed early, which has not invaded the left bronchus or lung, should be a favourable case for excision. The carcinomata of the greater part of the œsophagus above its cardiac end are the less malignant squamous epitheliomata but the more malignant adenocarcinoma of the cardiac end of the œsophagus is practically always an extension of the growth from the cardia of the stomach. Secondary or metastatic growths in the lymphatic glands, liver, pancreas or spleen occur early. The growth at the cardiac end of the œsophagus is inaccessible and early diagnosis is often very difficult. A laparotomy is necessary to ascertain its limits and the presence of secondary growths. Unfortunately, dysphagia is a comparatively late symptom but usually the only symptom which forces a patient to consult a doctor. When a growth of the cardia of the stomach extends to the œsophagus, dysphagia is too late a symptom. Pain at the ensiform cartilage, though not always present, is an earlier symptom, and I cannot find any mention of hiccup in the notes of the many cases I have seen. A preliminary temporary dysphagia resulting from the impaction of a large bolus of food is an occasional early symptom. The improved technique and the experience gained by this operation are useful in the treatment of mediastinal abscess, diaphragmatic hernia, congenital atresia and the thoracic stomach. Excision of an œsophageal growth has many hazards, as many as the " Grand National " to which it has been

compared. Shock and sepsis are perhaps the two greatest risks. Shock is diminished by gentle manipulation, blocking of the phrenic and even the vagi nerves with novocain, and the continuous blood transfusion. Sepsis may be controlled by a very strict aseptic technique, by the prevention of a leak of the anastomosis, a drainage tube and the administration of penicillin and the sulphonamides before and after operation are desirable. It may be useful to study the types of sepsis which follow perforations of the œsophagus.· The retropharyngeal and retro-œsophageal spaces are continuous and they are bounded in front by the pharynx and œsophagus, behind by the vertebral column and on each side by the carotid sheath in the neck and the mediastinal pleura in the thorax. Foreign bodies may perforate the œsophagus at once or perforation may be delayed and may occur by erosion. When the perforation is immediate or acute a cellulitis of the para-œsophageal space occurs and progresses to an acute mediastinitis, double pleural effusion and even pericarditis. If the patient lives long enough, suppuration and gangrene occur. The immediate perforation, either by a foreign body or by an instrument, is accompanied by shock and virulent sepsis and few, if any, survive. The delayed perforation by erosion such as that of a carcinoma is often followed by an abscess and the shutting off of the area of sepsis which later on may cause empyema, pyopneumothorax lung abscess or gangrene. The success of treatment depends on an early diagnosis. All cases of suspected foreign bodies in the œsophagus should be X-rayed and examined by the œsophagoscope. Moreover, even when the X-ray is negative and œsophagoscopy should be carried out. When the perforation of the œsophagus has occurred an X-ray will show air or gas in the mediastinal space with the displacement of the œsophagus or pharynx forwards, with widening of the mediastinal shadow. The para-œsophageal space can be drained in the neck just above the clavicle if the perforation is in the pharynx or the œsophagus above the second dorsal vertebra. If the perforation is lower down, a transthoracic approach is required and the mediastinum drained in both cases as soon as practical. A sub-diaphragmatic abscess has arisen from a perforation near the cardiac end. Drainage of the mediastinum above the clavicle in cases of delayed perforations has been successful. A few cases have been recorded of the abscess pointing into the œsophagus and this abscess has been opened through the œsophagoscope with success.

The lymphatic vessels of the upper œsophagus drain into the numerous groups of glands on its surface and into those of the mediastinum, the bronchial glands and the supra-clavicular group of cervical glands. There is a chain of lymphatic glands along each recurrent laryngeal nerve which are invaded early and drain into the supra-clavicular glands. The lymphatics of the lower end of the œsophagus drain into a mass of glands in the lesser omentum and on the lesser curvature of the stomach and the cardia of the stomach. There are small lymphatic glands on the upper surface of the diaphragm.

In conclusion I have endeavoured to establish a claim for a still closer and continued liaison between the clinical departments of teaching in large hospitals and the departments of anatomy and physiology. Moreover, if progress is to continue the special departments of a hospital should be equipped with a research and clinical laboratory including a skilled technician.

I am indebted to the Ferens Institute of Otolaryngology of The Middlesex Hospital in whose laboratories I have had the opportunity of working with the aid of a skilled technician. It is here that I have been able to study the anatomy of the pharynx and œsophagus by dissection of the full-term fœtus, and by a series of transverse and horizontal sections for the microscope of 8 to 20 weeks fœti adapted to show the form and relations of the œsophagus. The dissection of the full-term fœtus gives a more comprehensive view of the œsophagus and it is softer and more easily dissected than the adult. The use of the fœtus for dissection and for experimental operations is recommended. Fresh post mortem specimens of the cardiac end of the œsophagus have been obtained, examined and dissected. There is also a useful and comprehensive collection of pathological specimens in the museum of the Ferens Institute. Dr. Graham Hodgson and the staff of the X-ray department of the Hospital have given me every opportunity of studying the physiology of deglutition by observing a number of patients swallowing a barium meal with the fluourescent X-ray screen. I have had the opportunity of seeing Dr. Russell Reynold's cinematograph films on several occasions. Professor Whillis has kindly shown me his film of the mechanism of swallowing.

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" OBSERVABLES " AT THE ROYAL·COLLEGE OF SURGEONS

9. GILBERT'S BUST OF SIR RICHARD OWEN

IN THE ANNALS of August, 1947, on page 112 there is a short note on Sir Richard Owen, and a photograph of a bust by Sir Hamo Thornycroft, R.A., which had recently been presented to the College.

But in the Museum before the holocaust of 1941, there was a very remarkable portrait bust of Owen by Alfred Gilbert, R.A., the great artist who sculptured Eros in Piccadilly Circus, the Queen Alexandra Memorial at Marlborough House, and other works that are highly prized by his countrymen. Gilbert's bust of Richard Owen was commissioned by the College and was sculptured in 1895. It was very seriously damaged by bombs and fire, but, even when it had been reduced to an almost ruinous state it was obvious that it was the work of a great artist. It is indeed regarded as one of Gilbert's greatest works, and a special request was made for the loan of it when an exhibition of his sculpture was held in London some years before the war.

The bust of Richard Owen on May 11th, 1941.
By kind permission of the Associated Newspapers Ltd.

The Council of the College felt that they had a dual responsibility in deciding whether to preserve the remnants, or to restore this Work of Art —for they knew in what high esteem Gilbert's work was held, and they were especially anxious to have once more a worthy memorial of Richard

Owen. By a fortunate chance Mr. Gilbert Ledward, R.A., was led to interest himself in the problem. He is a native of Staffordshire, in which County the President of the College was also born, and they met when the President was presiding at a meeting of the Staffordshire Society. On seeing the condition of Gilbert's work, Mr. Ledward offered to see that the bust was properly restored, and cast again in bronze, and he insisted on giving his services gratuitously. The Council are extremely grateful for this generous gesture and count themselves fortunate indeed that such a famous Sculptor should undertake this task. Mr. Ledward has been confirmed in his judgment by Sir William Reid Dick, R.A., whose opinion he sought and who agrees that the bust should be completely restored.

The bust as it was before 1941, and as it will be once more after restoration.

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The Council thus have the voluntary help of two Master Sculptors of the day, both of whom have enriched London with public monuments. Mr. Ledward will be specially well known to readers for his figures on the Guards Memorial facing the Horse Guards Parade, and the figures in the cloisters of Westminster Abbey recently unveiled by Mr. Winston Churchill as a memorial to Officers and Ratings of the Submarine Branch of the Royal Navy who lost their lives in the 1914-18 war, and to all Ranks of the Commandos, the Airborne Forces, and the Special Air Service killed in the last war. Sir William Reid Dick's recent monuments to King George V and to President Roosevelt will be fresh in the minds of all.

So, out of adversity has come good fortune, and two famous Royal Academicians are giving their gratuitous help to the College, partly from their desire to serve a Sister Institution, and partly from a pious wish to restore the work of one of the greatest sculptors in the history of British Art.

W.-J.

SAYINGS OF THE GREAT

" Is it any wonder, gentlemen of the College of Surgeons, that your calling should exact the utmost that man can give—full knowledge, exquisite judgment, and skill in the highest, to be put forth, not at any self chosen moment, but daily at the need of others ? "—*Kipling.*

" Man, ' Symbol of eternity imprisoned into time,' it is not thy works, which are all mortal, infinitely little, and the greatest no greater than the least, but only the spirit that thou workest in, that can have worth or continuance."—*Carlyle.*

" The knowledge which a man can use is the only real knowledge which has life and growth in it, converts itself into practical power. The rest hangs like dust about the brain or dries like rain-drops off the stones."—*Froude.*

" If ever the human race is raised to its highest practical level intellectually morally and physically the science of medicine will perform that service."—*Descartes.*

SOME LESIONS OF THE EPIPHYSES

Lecture delivered at The Royal College of Surgeons of England

on

21st May, 1947

by

George Perkins, M.C., F.R.C.S.

Orthopædic Surgeon, St. Thomas's Hospital

THE TITLE OF THIS lecture is misleading. Most epiphyseal lesions are better described as lesions of the metaphysis, and it is on the epiphyseal line rather than on the epiphysis itself that I wish to direct your attention.

Fracture-separation of the epiphysis. The region of the growth disc is weaker than the shaft, and a force that would in an adult cause a fracture, in a child oftens injures the growth disc. The condition is rightly described as a fracture-separation, for the fracture line characteristically runs partly through the growth disc and partly through the bone of the metaphysis (Fig. 1). This is an important fact, because the part of the growth disc that has been injured often fails to grow as fast as the uninjured part, and the end of the bone becomes deformed. A deformity of the lower end of the tibia tilts the ankle joint out of the horizontal, and has often to be corrected by an osteotomy (Fig. 2). Although the younger the patient, the greater the probability of subsequent interference with growth, uneven growth of the disc is not inevitable. Fig. 3 shows the reduction of the displacement seen in Fig. 1. Fig. 4 taken 18 years later shows that the plane of the ankle has remained horizontal. Another characteristic of a fracture-separation is the rapidity with which the displaced fragment becomes immovable. The patient whose X-ray is shown in Fig. 1 was not seen until the tenth day after the injury, by which time closed reduction proved to be impossible. Fracture-separations are uncommon except at the lower end of the radius, the lower end of the tibia, and the upper end of the humerus. Apropos of a fracture-separation of the upper end of the humerus, it is remarkable how a gross angulation deformity can be ironed out in the course of growth. The patient in Fig. 5 was not seen until a week after the accident. As she was a girl with an attractive texture of skin it seemed a pity to mar it with an operation scar. No attempt was made therefore to reduce the displacement. Figs. 6a, 6b show the same humerus a year later; the two views are taken at right-angles to one another. I would remind you that the antero-posterior view of the normal upper end of the humerus in a child shows apparently two epiphyseal lines, the lower one of which is sometimes mistaken for a fracture.

The prognosis after a fracture-separation is always doubtful, and it is well to warn the parents that the effect on subsequent growth is unpredictable. I quote two cases. In the first, the lower end of the radius was broken and there was also a fracture-separation of the lower end of the ulna. The radius was straightened but the displaced epiphysis of the ulna could not be replaced. Nevertheless, one could not discern any difference between the radiograms of the two wrists two years later. In the second, there was a fracture-separation of the lower end of the radius, with no apparent injury to the lower end of the ulna, but an X-ray several years later showed an ununited fracture of the styloid and shortening of the ulna in relation to the radius.

Apophyses, that is non-articular epiphyses, also suffer injury but only from a traction force. The tension in the muscle whose tendon is attached to the apophysis is suddenly raised and the apophysis is pulled away from its host bone. The separation often appears complete in the radiogram, e.g. in the neighbouring or the lesser trochanter, but the apophysis usually re-anchors itself without assistance from the surgeon, and although sometimes in the radiogram of an adult a discrete bony fragment is seen in a tendon near its insertion, the function of the muscle is unimpaired.

More commonly, the apophysis is damaged by a succession of minor injuries not perceptible to the patient, and no obvious displacement is visible in the radiogram. Clinical attention is directed to the apophysis by localised swelling, localised tenderness, and pain when putting the muscle under tension. These partial separations are common at the knee under the term Schlatter's disease, and at the back of the heel under the term osteochondritis. Irregularities in the shape of the apophysis and the depth of the neighbouring growth disc, of no clinical significance, are common. These lesions do not merit serious treatment; it is usually sufficient to restrict the child's activities to those that do not cause pain. The symptoms fade in the course of a few months, leaving at times, however, some permanent enlargement of the apophysis. As a sequel, an enlarged tubercle tibial may show later in life just below the edge of a skirt, and to safeguard oneself against a mother's annoyance it is wise to overtreat rather than to undertreat Schlatter's disease in a girl and to warn the mother that an unsightly lump may be unavoidable.

Slipping of the upper femoral epiphysis. This might be termed a pathological separation of an epiphysis. Certain features distinguish it from the ordinary traumatic variety of fracture-separation. (1) It occurs only at one epiphysis—the upper epiphysis of the femur. (2) The line of cleavage is confined to the growth disc and does not enter the metaphysis. (3) The separation always begins gradually, and (4) it occurs at a particular age period—the period immediately preceding puberty.

The early minor slipping progresses into (*a*) continuous gradual slipping, or (*b*) a sudden severe displacement, causing in both cases an alteration

in the arc of movement at the hip—increased adduction and diminished abduction, and increased external rotation and absence of internal rotation. The progressive worsening of the displacement can be checked if the lesion is diagnosed in the earlier stage. Unfortunately although the diagnosis is easy to make, it is often missed. A child nigh on puberty complains of pain in the thigh after playing a game, and perhaps limps for a day or two. The symptoms disappear in a few days and reappear after resuming games. The symptoms may not be severe enough to bring the child to the doctor, and even if he sees the child, the doctor may fail to grasp the significance of the symptoms. His diagnosis of a sprained hip would exactly fit the symptoms and signs, but such a condition does not happen to a child. Little is to be made out on examination except slight limitation of movement at the hip joint. The radiogram is however diagnostic, provided one knows what to look for. The epiphyseal line may be wider and less clearly defined than on the normal side ; this, however, may not be obvious. But if in an antero-posterior view the line of the upper border of the neck is traced towards the head it will be seen to incline upwards sharply as it meets the head ; in Trethowan's words you " step up " onto the head. In the radiogram of an early case of slipped epiphysis this " step up " is absent and the upper border of the neck is continuous with the line for the head (Figs. 7a, 7b).

It is not possible to reduce a gradual slip, but neither is it necessary to do so, for provided the slipping does not progress the function of the hip will be more or less normal. To prevent further displacement it is only necessary to prevent weight-bearing, either by confining the child to bed or by making him walk on crutches with a patten on the other side high enough to prevent the foot of the affected leg from touching the ground.

When the diagnosis has been missed and the patient is not seen until the slipping is severe, one has to decide whether the severe slipping has been gradual or sudden. If gradual, reduction will not be possible and any attempt to reduce by rotating in and widely abducting the leg will risk damaging the blood supply to the head of the femur. In this dilemma, it is a good plan to apply traction to the leg (20lbs. skeleton traction with the foot end of the bed raised 20 inches). This pull will automatically reduce the displacement if this has been sudden. If the displacement has been gradual the traction is ineffective but does no harm. Reduction once obtained must be maintained (by continuing the traction) until the width of the growth disc is restored to normal. The epiphyseal disc fuses with the diaphysis soon after a successful reduction.

The initial slipping is presumably due to the body weight acting on a growth disc made susceptible by some disturbance of the endocrine balance. Slipping on one side is frequently followed by a slipping on the other side.

Infantile coxa vara. This in reality is another type of slipped epiphysis, although never referred to as such. The condition is rare. The symptoms

and signs suggest a congenital dislocation of the hip, except that on palpation the hollow in Scarpa's triangle, so characteristic of a congenital dislocation, is not present. In the radiogram, which reveals the true diagnosis, the medial projecting spur of the neck of the femur appears fractured (Fig. 8). It is uncertain whether the discrete fragment of bone is the result of injury or represents an independent centre of ossification. If a fracture, it is difficult to explain how and when it happened in the absence of any definite history of injury, and also difficult to explain why the fracture does not unite. Be that as it may, the mechanical sequel is what would be expected if a fibrous intersection was interposed between the fragment and the main bone ; the fibrous intersection stretches under the influence of the weight of the body, and the epiphyseal line tends to slip downwards and medially off the head. The slipping progresses over the course of years until in the radiogram in an adult the neck has disappeared and the head appears to spring directly from the shaft some distance down from the great trochanter. To avoid this progressive malformation of the upper end of the femur, a wedge subtrochanteric osteotomy should be done as soon as the condition is discovered despite the absence of any but trivial symptoms at the time. After the osteotomy, the leg is held abducted at right angles to the trunk. Fig. 9 shows that when the leg is brought down to the straight position after the union of the osteotomy, the object of the operation has been achieved, namely, the changing of the epiphyseal line from the vertical to the horizontal plane, thereby abolishing the sheering stress.

Pseudocoxalgia. It seems desirable to retain this name for this well-known condition because almost the only thing we know about it is that it mimics tuberculosis of the hip joint. The characteristic cycle of radiographic changes are comprehendable on the assumption that the blood supply to the epiphysis is cut off. The period of avascularity must be brief because the stages from fragmentation onwards are dependent on an effective circulation. In the stage of onset, the joint space appears to be increased in depth because the cartilaginous envelope goes on growing (being nourished by the joint fluid), while the bony nucleus ceases to grow (on account of the interruption of its blood supply) and remains smaller in comparison with the nucleus of the opposite side, the growth of which has not been interfered with. The increase in the density of the bony nucleus is consistent with the cutting off of its blood supply, for dead bone is denser than living bone. The epiphysis is composed now of a large amount of cartilage with a small bony core and cannot resist deformation under the pressure of the weight of the body—hence the flattening and lateral expansion of the head. In the stage of fragmentation the circulation through the epiphysis has been restored and the dead bony nucleus is slowly absorbed in a patchy and piecemeal fashion, giving rise to the radiographic appearance of fragmentation. By now, if not before, the epiphysis has been flattened and in the radiogram is seen to be diminished in depth and increased in width. As the dead bone is absorbed, new bone

Fig. 1

Fig. 3

Fig. 2

Fig. 4

Fig. 5

Fig. 6A

Fig. 6B

Fig. 7A

Fig. 7B

Fig. 8

Fig. 9

is laid down in its place. Gradually the dead bony nucleus is entirely replaced by new bone, but the new epiphysis is shallower and wider than the original.

Although it is generally agreed that the radiographic changes are the natural consequence of an aseptic necrosis the cause of which is problematical, this uncertainty has little bearing on the principles of treatment. The surgeon is faced with two problems : (1) How to prevent the flattening and spreading of the epiphysis, and (2) How to restore a spherical shape to a flattened head. Early diagnosis is all-important. Apart from that, the relief of weight-bearing will tend to prevent flattening. Also it is theoretically advisable to apply traction to the leg to pull the head of the femur away from the roof of the acetabulum, thus shielding the epiphysis from all deforming influences. The question arises whether it is possible to reshape a head that has already been flattened. My colleague, Mr. Furlong, argues that if the head is thrust deeply into the acetabulum by holding the leg in wide abduction, it will be moulded to the shape of the acetabulum and so again become spherical. It is difficult to assess the value of splinting the leg in wide abduction because the time of onset of treatment is a much more important factor in deciding the ultimate shape of the head. The younger the child when first seen, the better the prognosis, and this fact must not be lost sight of when appraising the value of different forms of treatment.

MONTHLY DINNERS

Monthly dinners held in the College will be resumed on 13th October. The following are entitled to attend with their guests. All Diplomates and students of the College, and Members of the Associations linked to the College through the Joint Secretariat. It is not necessarily intended that guests should be members of the medical profession.

The dinners will be at 7 p.m. on the following Wednesdays :—13th October, 10th November, and 8th December, 1948. There is an inclusive charge of £1 5s. 0d. (including drinks), which must be sent with the application to the Assistant Secretary at least a week before the date of the dinner. The dress is Lounge Suit or Uniform.

DIARY FOR SEPTEMBER
(15th-30th)

Wed.	15	5.00	PROF. B. RIENHOFF—Moynihan Lecture—Present Status and Treatment of Malignant Tumours of the Lung.*
		5.00	MR. W. KELSEY FRY—Late Complications following Fractures of the Jaws.
		6.15	MR. A. C. MCLEOD—Restoration following Fractures.
Thur.	16		First Membership Examination begins.
		5.00	PROF. F. H. BENTLEY—Cleft Palate.
Fri.	17		D. C. H. Examination begins.
		5.00	MR. R. C. BROCK—Lung Diseases in Relation to Dental Operations.
		6.15	MR. S. A. RIDDETT—Complications following Extractions.
Mon.	20	5.00	DR. HEDWIG KUHN—Eye Problems in Industry.*
		5.00	MR. L. E. C. NORBURY—Post-operative Treatment.
		6.15	DR. R. WEAVER—Fluorosis.
Tues.	21	5.00	MR. C. BOWDLER HENRY—Alveolectomy and Osteotomy.
		6.15	MR. G. PARFITT—Preventive Measures—Research and Practical Aspects.
Wed.	22	5.00	SIR CECIL WAKELEY—Surgery of the Salivary Glands.
Thur.	23	5.00	MR. T. G. WARD—Surgical Extractions.
		6.15	MR. H. T. ROPER-HALL—Therapeutics in Dental Surgery.
Fri.	24	5.00	PROF. F. C. WILKINSON—Replantation of Teeth.
		6.15	MR. D. W. C. NORTHFIELD—Head Injuries.
Mon.	27	5.00	MR. P. H. MITCHINER—Treatment of Wounds.
		6.15	DR. S. BEHRMAN—Facial Neuralgias.
Tues.	28		Final Membership Examination beings.
		5.00	MR. RAINSFORD MOWLEM—Osteomyelitis of the Mandible.
		6.15	PROF. M. A. RUSHTON—Dental Caries (Part I).
Wed.	29	5.00	MR. S. ROSS—The Pulpless Tooth and Apicectomy.
		6.15	PROF. H. H. STONES—Oral Tumours.
Thur.	30	5.00	MR. V. E. NEGUS—Diseases of the Maxillary Antrum.
		6.15	MR. C. L. ENDICOTT—Etiology and Diagnosis of Malocclusion.

* Not part of courses.

Fri.	1		Final L.D.S. Examination (Part I) begins.
		5.00	MR. R. S. TAYLOR—Alveolar Abscess.
		6.15	PROF. M. A. RUSHTON—Dental Caries (Part II).
Mon.	4	5.00	MR. G. BLACKBURN—Traumatic Injuries of the Abdomen.
Tues.	5	5.00	MR. A. B. WALLACE—Treatment of Burns.
Wed.	6	5.00	PROF. F. H. BENTLEY—The Interpretation of Visceral Pain.
Thur.	7		Final L.D.S. Examination (Part II) begins.
Fri.	8		D. Phys. Med. Examination (Part I) begins.
		5.00	MR. H. JACKSON BURROWS—Bone Graft Surgery.
Mon.	11	10.00	DR. W. W. MUSHIN—Local Analgesia.
		11.15	DR. W. W. MUSHIN—Local Analgesia.
		5.00	DR. W. W. MUSHIN—Local Analgesia.
		5.00	MR. F. S. COOKSEY—Rehabilitation in Surgery.
Tues.	12	10.00	MR. C. LANGTON HEWER—Oxygen Therapy.
		11.15	DR. A. H. GALLEY—Caudal Analgesia.
		5.00	DR. M. DAWKINS—Epidural and Posterior Splanchnic Block.
		5.00	MR. R. C. BROCK—Surgery of the Heart and Great Vessels.
Wed.	13	10.00	DR. J. K. HASLER—Spinal Anæsthesia.
		11.15	DR. S. ROWBOTHAM—Continuous Spinal Anæsthesia.
		5.00	DR. B. L. S. MURTAGH—Avoidable Accidents in Anæsthesia.
		5.00	PROF. J. R. LEARMONTH—The Pathological Physiology of Peripheral Arterial Disease.
		7.00	Monthly Dinner for Fellows, Members and Licentiates (*see page* 162).
Thurs.	14		Primary F.D.S. Examination begins.
		10.00	DR. E. LANDAU—Premedication.
		11.15	DR. K. LLOYD-WILLIAMS—Obstetric Anæsthesia (including Cæsareans).
		5.00	DR. R. J. MINNITT—Obstetric Analgesia.
		5.00	MR. DENIS BROWNE—Surgery of Congenital Deformities of the Extremities.
Fri.	15		D.M.R.D. (Part I), D.M.R.T. (Part I), and D. Phys. Med. (Part II) Examinations begin.
		10.00	DR. S. ROWBOTHAM—The Relation of Endocrine Imbalance to Anæsthesia.
		11.15	DR. E. A. PASK—Circulatory Depression.
		5.00	DR. E. A. PASK—Respiratory Depression.
		5.00	MR. T. HOLMES SELLORS—Surgery of Pulmonary Tuberculosis.
Mon.	18	10.00	DR. R. P. HARBORD—Shock.
		11.15	DR. G. ORGANE—Cardiac Arrest.
		5.00	DR. B. JOHNSON—Analepsis and Resuscitation.
		5.00	DR. D. W. SMITHERS—High Voltage X-rays in the Treatment of Malignant Tumours at a Depth.
Tues.	19	10.00	DR. H. L. MARRIOTT—Saline, Plasma and Blood.
		11.15	DR. H. L. MARRIOTT—Saline, Plasma and Blood.
		5.00	DR. R. WOOLMER—Convulsions.

Wed. 20 10.00   Dr. W. D. Wylie—Pulmonary Complication, Prevention and Treatment.

         11.15   Dr. H. G. Epstein—Physics in Anæsthesia.

         5.00   Dr. J. Challis—Ether Anæsthesia.

         5.00   Prof. J. Paterson Ross—Surgery of the Sympathetic Nervous System.

Thur. 21   Final F.D.S. Examination begins.

         10.00   Dr. W. S. McConnell—Nitrous Oxide-Oxygen and Dental Anæsthesia.

         11.15   Dr. W. W. Mushin—The Absorption Technique.

         5.00   Dr. J. Challis—Cyclopropane, Chloroform and Trilene Anæsthesia.

         5.00   Mr. P. H. Mitchiner—Surgery of Sepsis.

Fri. 22   D.M.R.D. (Part II), and D.M.R.T. (Part II), Examinations begin.

         10.00   Mr. I. W. Magill—Intubation.

         11.15   Dr. B. Johnson—Intravenous Anæsthesia.

         5.00   Dr. B. Johnson—Intravenous Anæsthesia.

Mon. 25 10.00   Dr. T. Cecil Gray—Curare and Like Substances.

         11.15   Dr. T. Cecil Gray—Curare and Like Substances.

         5.00   Dr. A. Parry Brown—Anæsthesia for Thoracic Surgery.

Tues. 26 10.00   Dr. A. Parry Brown—Anæsthesia for Thoracic Surgery.

         11.15   Dr. E. H. Rink—Anæsthesia for Cardiac Surgery.

         5.00   Dr. G. Organe—Abdominal Relaxation.

Thur. 28   Final F.R.C.S. Examination (Ophthalmology and Otolaryngology) begins.

         10.00   Dr. R. W. Cope—Anæsthetics for Children.

         11.15   Dr. V. Toldman—Ethyl Chloride, Visthene.

         5.00   Dr. F. T. Evans—Anæsthesia for Perineal Surgery.

Fri. 29 10.00   Dr. A. J. H. Hewer—Anæsthesia in Cranial Surgery.

         11.15   Dr. G. Edwards—Basal Narcosis.

         5.00   Dr. C. F. Hadfield—Explosions—Preventions.

All Lectures during October form part of courses.

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A course of lectures in the Basic Sciences will commence on 25th October. Details will be published in the October number of the Annals, or may be obtained on application to The Secretary, Post-Graduate Education Bureau, Royal College of Surgeons of England.

ACUTE INFECTIONS OF THE FACE AND NECK OF DENTAL ORIGIN

Charles Tomes Lecture delivered at the Royal College of Surgeons of England
on
28th July, 1948
by
Malcolm Wallace Carr, D.D.S., F.A.C.D.
New York

THE FREQUENCY OF occurrence, high morbidity or relatively high incidence of mortality of a disease or clinical entity are factors that cause special concern in clinical practice, and these factors stimulate investigation or experimental research in order to determine the nature, cause, treatment and prevention of the particular condition under observation.

The incidence of serious acute infections of the face and neck arising from dental origin is high and the mortality of these advanced infections is higher than is generally suspected. The reality of these significant facts forces the conclusion that acute infections of the maxillo-facial area should always be considered potentially serious. Any infection in the face or neck of dental origin, which at its outset is deeper than the skin and immediate subcutaneous tissue, should be considered a deep neck infection. In addition to being regarded as deep in location, deep neck infection is so designated because it originates from a deep source or portal of entry, such as the periapical region of teeth, the pharynx, the tonsils or deep lymphatic structure.

The clinical syndrome of deep infections frequently presents a complex problem, the comprehension of which may be facilitated, however, by analysis of the complexity into its component parts. Thus, it will frequently be found that a number of separate conditions (the nature of which may be understood) are, in their composite, responsible for the complexity of the syndrome. Therefore, in any treatment planning it is essential first to understand the nature of the several conditions that may be contributing to the composite problem, and to institute treatment, surgical or medical, in accordance with a well-planned logical sequence of procedure.

The clinician must have a clear concept of ætiology, mode of extension, symptomatology of regional manifestations and the possible local as well as constitutional complications. Furthermore, an accurate knowledge of the anatomical structures involved is fundamental in order to understand the pathogenesis of infection spreading from dental tissues, and surgical treatment must be based upon a precise knowledge of regional surgical anatomy and performed in accordance with biological principles.

Ætiology
The ætiology of infections of the face and neck may be considered from the standpoint of bacteriology and the location of the portal of

entry. The majority of deep infections extending from the dental region are caused by pyogenic micro-organisms, the streptococcus group (hæmolytic and non-hæmolytic) and the staphylococci. Mixed infections, however, are most common and a variety of organisms may be isolated by culture or found in direct smear, including the fusospirochetes of Vincent's infection.

In oral pathology there are three fundamental dental diseases which may act as portals of entry. These diseases affect the structure of the teeth or involve the investment tissues. The simplest means of alluding to these primary dental diseases is to refer to them as periodontal infection, dental caries and periapical infection. Periodontal infection and periapical infection are the principal exciting causative factors that contribute to the clinical frequency of acute infections of the cervico-facial area. Secondary infection following traumatic injury of the bones and soft tissue of the face, secondary infection of large cysts, complications of affections of the salivary glands and secondary infection accompanying lesions of syphilis, tuberculosis and neoplastic disease may be responsible also for serious acute infections in tissues contiguous to the oral cavity.

The portal of entry, however, may be non-odontopathic, and it is therefore necessary, in establishing a differential diagnosis, to consider ætiologic factors other than dental. Deep infections of the neck may result from primary infection in the pharynx, and the retropharyngeal space; the tonsils (acute follicular tonsillitis or peritonsillar abscess); infection of the nose and accessory nasal sinuses; infection from the temporal bone, particularly the mastoid process; infections of the salivary glands and lymph nodes, particularly cervical adenitis in children; and, infections of the hypopharynx, œsophagus, larynx and trachea due to trauma or foreign body. Serious secondary infection also may accompany the oral lesions in terminal stages of the blood dyscrasias.

Periodontal Disease.—Periodontal disease is confined to the periodontium, the investment tissue of the teeth, comprising the alveolus and the overlying mucous membrane. The clinical varieties of periodontal disease depend upon the intensity of the inflammatory process and range from a simple gingivitis to extensive suppurative periodontoclasia. The process is usually chronic, although acute exacerbation may occur and infection from the gingiva may thus develop into an active subperiosteal infection. In this instance the infection spreads by direct extension beneath the periosteum. Clinically, this condition is most commonly encountered as a subperiosteal infection of the external surface of the mandible. The course may be rapid, and within a short period of time the infection may involve one side of the mandible, including the ramus, or may even spread beyond the median line to involve the entire mandible. Perforation of the periosteum permits the infection

to gain access to the submaxillary or sublingual tissues and cervical cellulitis develops. Thus subperiosteal infection of the mandible arising from periodontal disease may be responsible for extensive osteomyelitis, resulting in complete destruction of a large portion of the bone, which later may sequestrate *en masse*.

Fusospirochetal Infection.—Fusospirochetal infection (Vincent's infection) is a specific periodontal disease. The spirochete of Vincent and the fusiform bacilli are probably the most important members in a symbiotic group of anærobic organisms, which is capable of initiating a severe or even fatal disease. The fusospirochetes may be found, in small numbers, in the mouth without any clinical evidence of disease, and usually concentrated in primary incubation zones, which may be defined as areas where a combination of factors favour the multiplication of anærobic organisms. These areas are essentially under gingival flaps on partially erupted third molars and subgingival pockets of infection elsewhere in the mouth. Under certain conditions, particularly surgical trauma and in the presence of lowered general resistance, these organisms multiply rapidly and spread from the primary incubation zone to deeper contiguous tissues, and thus invade the sublingual or deep submaxillary regions. Locally, fusospirochetal infection is manifested as an ulceromembranous stomatitis, necrotic stomatitis or in advanced stages as gangrenous stomatitis, which may simulate noma or cancrum oris. Surgical intervention within the oral cavity in the presence of periodontal infection, and particularly in the presence of fusospirochetal disease, is an exceedingly hazardous procedure. The most severe and fatal cases of post-operative infection reported in literature have been attributed to activation or exacerbation of pockets of periodontal infection. Extension of anærobic infection from the mouth into the deep submaxillary tissues is not uncommon, and at operation sloughing of the fascial planes and deep connective tissue of the neck may be encountered.

Periapical Disease.—Periapical disease is usually the result of dental caries, and may be defined as that disease process which breaks down, or tends to break down, the bony tissue beyond the apex of the root of the tooth, causing rarefying osteitis in which a progressive thickening of the pericemental membrane of the tooth occurs at the expense of the bone. As proliferation of round cells occurs, the bone becomes rarefied and finally destroyed, leaving a space filled with a mass of chronic inflammatory granulation tissue—the granuloma. The infection is, therefore, first, intraosseous, but as rarefaction of bone continues, perforation of either the external or internal plate of bone may occur and then the infection becomes extraosseous or subperiosteal, and may now extend rapidly to deeper contiguous tissues of the face or neck. The sequence of clinical events that follows perforation depends, to a considerable degree, upon the location of the perforation, the local tissue

resistance, the virulence of the infection and the general resistance of the patient.

Mode of Extension

Knowledge of the portal of entry of the infection suggests the pathway of extension, possible or probable complications, and indications for surgical management. Infection may spread from the site of perforation by direct extension or it may spread independently by way of the vascular channels.

Direct Extension by Anatomical Continuity: When the inflammatory or suppurative process has gained access to the contiguous connective tissues of the face or neck, and when pus has formed and is accumulating under pressure, the infection usually spreads by direct extension along the line of lymphatic drainage, the fascial planes and vascular sheaths, with a tendency to localize in one or more of the potential anatomical spaces and in accordance with the line of least resistance.

Therefore, clinically, and from the standpoint of surgical pathology, these infections constitute a true cellulitis (extending by anatomical continuity through connective or cellular tissue) and are not primarily a lymphadenitis. Although the lymphatics play a major rôle in any infection, and in acute inflammation, the regional lymph nodes become enlarged, tender and palpable, in the presence of acute cellulitis the accompanying œdema and connective tissue involvement rapidly overshadow the lymphatic manifestations. In the maxillo-facial region, however, there is an efficient lymphatic capillary reticulum which drains into a series of slightly larger vessels called the " collectors." These collecting vessels pass through masses of lymphoid tissue, the superficial and deep lymph nodes, and from the deep cervical nodes other large lymphatic vessels pass on to join the venous system at the base of the neck. Therefore, thrombosis of the internal jugular vein and bloodstream infection are always possible complications.

Maxillary Teeth.—Direct extension of infection from the maxillary teeth may spread so as to involve various contiguous anatomical structures, depending upon the position of the infected tooth, the location of the perforation of bone and the pathway that the infection follows :—

(1) Direct extension of infection through bone may cause infection of the maxillary sinus, the anterior nasal fossa or, rarely, the orbit. Osteomyelitis of the maxilla may result from extensive intraosseous infection of this bone.

(2) Direct extension of infection from bone into the superficial soft tissues of the oral cavity may occur following perforation of an intra-alveolar abscess and cause a superficial buccal (vestibular) abscess or a labial abscess ; a superficial infraorbital abscess, attended usually by extensive paraorbital œdema, or a superficial palatal abscess. Incision and drainage of these superficial abscesses is generally followed by resolution without complication.

(3) Direct extension of infection from bone into the deeper contiguous connective tissues may occur following perforation of an intraosseous abscess. The inflammatory or suppurative process in this instance may spread to remote regions, following fascial planes and in accordance with the line of least resistance, and may invade and localize in the following potential anatomical spaces :—

(*a*) The masticator space in the region of the parotid gland.

(*b*) Pterygomaxillary (sphenomaxillary) space.

(*c*) Temporal spaces, where pus may localize superficial to the temporal muscle in the superficial temporal space, or deep to the temporal muscle in the subtemporal or deep temporal space.

Mandibular Teeth.—Although infection from the maxillary teeth may extend by anatomical continuity to contiguous tissues and present serious complications, extensive suppurative processes from mandibular teeth are more common, usually more complicated, and always potentially more serious. Furthermore, clinical experience has shown a higher incidence of serious infection from mandibular molar teeth than from all other teeth. The reason for this is obvious when consideration is given to the regional anatomy of the soft tissues contiguous to the mandible, particularly the attachment of the mylohyoid muscle.

Direct extension of infection from mandibular teeth may spread so as to involve the following contiguous anatomical structures :—

(1) The infection may remain intraosseous and cause an extensive primary osteomyelitis.

(2) Direct extension of infection from bone into the superficial soft tissues of the oral cavity may occur following perforation of an intra-alveolar abscess and cause a superficial buccal (vestibular) abscess ; a superficial (submucous) abscess in the floor of the mouth, or a superficial retromolar abscess.

(3) Direct extension of infection from bone, into deeper contiguous connective tissues, however, may occur following perforation of an intraosseous abscess and extend to remote regions, following fascial planes, and ultimately localize in one or more of the following anatomical spaces :—

(*a*) The masticator space.

(*b*) The temporal spaces.

(*c*) The submaxillary space, which may be deep or superficial, via subcutaneous submaxillary extension.

(*d*) The pharyngomaxillary space.

(*e*) The spaces of the sublingual region in the visceral portion of the neck, the superior geniohyoid space, the inferior geniohyoid space, or beneath the mylohyoid.

Infection may also spread by anatomical continuity into the posterior mediastinum.

Extension of Infection by Vascular Channels: Infection may spread from the maxillary region by venous vascular channels entirely independent of extension by anatomical continuity or the vascular channels may become secondarily involved.

The blood vessels of the oral cavity may thus serve as a pathway by which infection may spread from the teeth and contiguous maxillo-facial tissues, chiefly along the venous channels which follow well-known anatomical distributions. The primary involvement of the venous channels may be through the pterygoid plexus, and cavernous sinus thrombosis may be a direct complication from thrombophlebitis of this venous plexus, or retrograde infection may take place by way of the facial vein.

The veins in this region have no valves, consequently extensive œdema causing venous occlusion by external compression, or internal blockage due to thrombosis, may prevent the normal downward flow of blood and permit a retrograde circulation through the pterygoid plexes, emissary vessels or via free communication anteriorly with the facial veins, and thus cavernous sinus thrombosis may be a direct complication. When an infected thrombus is propagated along this retrograde pathway, infection enters the skull, usually with fatal termination due to meningitis.

Serious or grave complications of deep neck infections are the result of septicæmia or bacteræmia, anoxia or asphyxia, and hæmorrhage. Any one of these complications may be the primary cause of death. Septicæmia is the most common complication. Blood stream infection is indicated by marked leukocytosis, abrupt rise and fall in temperature, chills and sweats, and positive blood culture. Infection from the maxillo-facial region may invade the venous circulation and cause septicæmia or bacteræmia which by metastasis from the primary neck infection may be responsible for severe damage or secondary abscesses in remote organs, such as the heart, liver or kidneys. These lesions are found frequently at autopsy. Spread of infection by venous channels may also be responsible for hæmatogenous osteomyelitis and result in multiple areas of secondary metastatic bone lesions, principally the long bones. Hæmatogenous osteomyelitis of the jaw may occur by the same process and be secondary to some primary osteomyelitic lesion elsewhere in the body or secondary to bacteræmia following the exanthematous fevers.

Erosion of blood vessels due to infection is always a serious complication. Swelling due to hæmatoma resulting from extravasated blood must be differentiated from abscess. Erosion of the internal or external carotid arteries may occur and result in fatal hæmorrhage. Ligation of the external carotid or common carotid artery may be necessary.

Terminal pneumonia is also a complication of deep neck infections.

Clinical Varieties

For practical purposes the clinical varieties may be classified as acute non-suppurative inflammations and acute suppurative infections.

The acute non-suppurative inflammations are usually circumscribed areas of local tissue reaction due to low-grade infection, trauma or laceration. The process is in part inflammatory and in part passive venous or lymphatic engorgement. These non-suppurative inflammations may terminate by resolution or the element of the transudate may break down and suppurate. Occasionally, congestion or œdema is extensive and early incision may be indicated, even before suppuration has taken place.

Acute suppurative infections may be either circumscribed or diffuse. In acute circumscribed suppurative infection, pus has spread from some primary focus, and may remain, for the time being, localized as a subcutaneous extension or remain confined within the boundaries of the anatomical space originally invaded.

Acute diffuse suppurative infection (diffuse cellulitis) is an active suppurative process that does not remain localized but tends to extend by progressive invasion of connective tissue, breaking down areolar tissue and extending along planes of fibrous tissue that envelop muscles, that form the sheaths of the great vessels and the capsular layers of glands. Thus, the entire cervico-facial area may become involved as part of the same process, extending from the temporal region to the clavicle. There is, however, an ultimate tendency for these diffuse infections to localize in one or more of the potential anatomical spaces and it is frequently necessary, in order to establish adequate drainage in the cervico-facio-temporal infections, to resort to multiple incisions and counter drainage.

Ludwig's Angina: Ludwig's angina may be defined in general as a diffuse septic inflammatory cellulitis of the floor of the mouth. Numerous definitions for Ludwig's angina are found in the literature and vary in accordance with the author's concept of the pathogenesis and surgical pathology of the disease. Some clinicians look upon the condition as a distinct clinical entity, while others are inclined to classify (incorrectly) any sublingual infection as Ludwig's angina.

Symptomatology and Diagnosis

Subjective Symptomatology: Swelling, pain and trismus are the most constant local symptoms of the acute infections. Difficulty of respiration and deglutition are indications of impending serious complications. Lassitude and malaise, insomnia and anorexia are toxic constitutional symptoms usually accompanying these infections.

Objective Symptomatology: Much is to be gained by a careful and complete examination of the patient at the time of the first examination, and if immediate operation is not decided upon, subsequent observations should be considered in contrast with the observations made at the time of the first examination, and the changes in local and constitutional symptoms interpreted in terms of indication for operation or justification for pursuing a conservative course and delaying operation.

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A well-circumscribed swelling, moderate or excessive tissue tension (indicated by redness and shine of tissue), pitting on pressure or fluctuation, and extreme tenderness upon superficial palpation, are local signs indicative of a localized superficial suppurative process which is probably well walled off.

The superficial vestibular submucous abscess, the superficial submucous abscess in the floor of the mouth, and infections that have extended directly from the mandibular periosteum and localized as a subcutaneous submaxillary extension, lying just beneath the platysma, are clinical examples of these well-localized infections. They may, however, be accompanied by considerable œdema, which makes them appear clinically more extensive than they really are. The indication for incision of these infections is usually obvious, and it is probable that the abscess cavity will be reached easily by superficial incision and that deep dissection will not be necessary.

Although the lymphatics may be primarily involved in the course of these infections and the nodes may be palpable and tender, œdema and induration frequently develop so rapidly that palpation of the nodes may not be possible, nor is it of any diagnostic importance to do so. Similarly, pitting on pressure and the physical signs of fluctuation are not always safe criteria in the diagnosis of pus. When pus has reached superficial or subcutaneous tissues, fluctuation is readily elicited. However, some of the more severe suppurative infections of the neck fail to elicit fluctuation due to superimposed œdema and induration or because of overlying muscles or heavy fascial planes, as occur in the temporal region. Clinical experience often confirms that notwithstanding the absence of fluctuation, pus has been found at operation in the deep cellular structures or anatomical spaces.

Whereas many of the signs and symptoms of deep infections are similar, there is, nevertheless, considerable variation in the character and intensity of the manifestations.

It is important, therefore, to recognize clinical signs and symptoms that indicate serious involvement of the visceral structures of the neck and symptoms that suggest systemic complications.

Diffuse, hard, non-fluctuant, non-pitting swellings which produce furrowing or wrinkling of cutaneous tissue with thickening and induration of deeper tissues and elevation of the floor of the mouth with fixation of the tongue, are signs which indicate serious deep infections. There is usually trismus, occasionally torticollis and always *fetor ex ore.* Painful and difficult deglutition (odynophagia) indicates extensive œdema at the base of the tongue ; embarrassed or difficult respiration which may be rapid and shallow and accompanied by dyspnea with cyanosis and anoxia, and, dysphonia or aphonia may indicate laryngeal involvement with œdema of the glottis. A patient with these symptoms is restless, shows extreme anxiety and is gravely ill. The sepsis produced by virulent deep infection also manifests symptoms of systemic involvement. Fever

may be continuously high (102°-104°) or there may be high elevations of temperature with sudden fall in temperature, and there may be chills followed by profuse sweating which may indicate a blood stream infection. The pulse is usually rapid, and may be of poor quality, the respirations are rapid and shallow, mild to extreme dehydration and malnutrition are common. Hæmatology will show usually marked leukocytosis (15,000 to 40,000 white blood cells) and polymorphonuclear cells as high as 95 per cent. There also may be anæmia. Frequent complete blood counts and sedimentation rate observations will indicate valuable information, both as to diagnosis and prognosis, and when sepsis is severe it is advisable to do complete counts every 24 to 48 hours, and if blood stream infection is suspected, blood cultures should be done. Urinalysis should be done daily.

Cavernous sinus thrombosis will produce special signs and symptoms, which include severe head pain, extreme pyrexia, œdema and venous congestion about the orbit with proptosis, paralysis of the ocular muscles with fixation of the pupil, disturbances in vision and choked disc with retinal hæmorrhage.

Surgical Management

Diffuse cellulitis which has invaded deep cellular structures, or infection that has localized in one of the deeper anatomical spaces require extensive surgery and many times deep dissection or delamination of the fascial planes is necessary in order to establish adequate drainage.

The indication of the optimum time for surgical intervention in these cases is not always easily determined. Operation before the infection has been walled off or inadequate drainage may precipitate serious complications, and delayed operation may be responsible for increased toxæmia or contribute to laryngeal œdema.

There is, however, at least theoretically, an optimum time for incision and drainage of acute suppurative infections. If sufficient time is afforded for clinical observation, operation should be decided upon after careful consideration of all related signs and symptoms. Once a severe sepsis is definitely established and persists after reasonable efforts to bring about its subsidence or resolution with chemotherapy and the antibiotics, surgical drainage should be considered, and under these conditions probably should not be delayed beyond 48 hours.

Incision for drainage should be made at a dependent point and dissection performed so as to reach the portal of entry and expose the contiguous anatomical areas invaded by the original infection.

All patients with neck infections constitute serious anæsthetic risks. Nitrous oxide-oxygen, sodium pentothal, and avertin are contraindicated. Ether is a respiratory and circulatory stimulant and probably still remains the safest anæsthetic agent, particularly if the endotrachial technique can be employed by direct laryngoscopy and per oral intubation.

When the patient is *in extremis* general anæsthesia is contraindicated and subcutaneous local anæsthesia is the anæsthetic of choice. Pre-medication is probably undesirable, drugs which are depressants should be avoided and free airway and pulmonary ventilation must be maintained at all times.

Patients with infections and fever should not remain ambulatory but should be required to rest in bed. If there is deep visceral involvement in the neck the patient should be placed in a semi-Fowler's position. Therapy with sulphonamides and penicillin should be initiated immediately. The sulphonamide drugs exert their greatest effect on the streptococcus group, particularly the hæmolytic type and, to a lesser extent, on the staphylococcus group. Penicillin acts against gram-positive micro-organisms and is potently active against the staphylococcus.

Penicillin is the best therapeutic agent for sepsis and sulphadiazine is at present the preferred sulphonamide. When sulphonamides are administered the blood concentration and urinalysis should be under constant observation. Sodium bicarbonate should be given with the sulphonamides and adequate water must be consumed so that at least one litre of urine is excreted daily.

The importance of fluid intake cannot be over-emphasized. Patients with deep neck infections are usually dehydrated, first, because of inability to take adequate fluids by mouth, and secondly, because of loss of fluids by sweating due to fever. Dehydration must at all times be prevented, and if adequate fluids cannot be tolerated by mouth, fluids in the form of saline with glucose (5 per cent.) must be administered by clysis or by the intravenous route. Therapeutic doses of X ray radiation may be indicated if the infection is diffuse and indurated. Blood transfusion may be indicated for anæmia produced by hæmolytic infections, and will be helpful in increasing general resistance and overcoming protein depletion.

An established airway must be maintained at all times, pre-operative, during operation and especially post-operative, when exacerbation and œdema of the glottis may occur. Inhalation of oxygen and carbon dioxide, or the use of an oxygen tent, may be necessary. Equipment for suction and tracheotomy should be available in the operating room and at the bedside.

Patients with deep infections of the cervico-facial area require the most thoughtful, surgical, medical and nursing care. Fundamental knowledge of ætiology, pathways of extension, regional anatomy and principles of surgery are essential for successful management of the patient, and judgment, surgical skill and resourcefulness are pre-requisite qualifications that are attained only by sufficiently prolonged clinical experience.

The incidence of morbidity and mortality of infections of the face and neck of dental origin may be reduced by prevention, effective early

treatment based upon accurate knowledge of surgical anatomy and surgical pathology, and by the aid of modern therapeutic agents.

The reward of the practice of dentistry and medicine lies not only in service to others and in the satisfaction derived from intellectual interchange of thought, but also in the realization that both professions are still but pioneers and in the hope that by co-operation and concentrated effort, the development of improved procedures and useful discoveries may be even more effective in relieving human suffering and extending useful lives.

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MONTHLY DINNERS

Monthly dinners are held in the College on the second Wednesday of each month.   The following are entitled to attend with their guests.   All Diplomates and students of the College, and Members of the Associations linked to the College through the Joint Secretariat.   It is not necessarily intended that guests should be members of the medical profession.

The dinners will be at 7 p.m. on the following Wednesdays :—10th November, and 8th December, 1948.   There is an inclusive charge of £1 5s. 0d. (including drinks), which must be sent with the application to the Assistant Secretary at least a week before the date of the dinner. The dress is Lounge Suit or Uniform.

ENLARGEMENTS OF THE TESTIS AND EPIDIDYMIS

Erasmus Wilson Demonstration delivered at the Royal College of Surgeons of England

on

3rd March, 1948

by

Philip H. Mitchiner, C.B., C.B.E., T.D., M.S., F.R.C.S.

Surgeon to St. Thomas's Hospital

ERASMUS WILSON, by whose generosity and in whose memory these demonstrations are established, was born in Marylebone High Street in 1809, and died in 1884, three years after being President of this College. His medical education was partly at private anatomy schools and partly at St. Bartholomew's Hospital. Subsequent to qualification he taught anatomy at various private schools, including one of his own, and also at The Middlesex Hospital, to the Staff of which he was ultimately elected as a surgeon. His chief interest, however, seems to have been in dermatology, and he was a pioneer in this speciality in which he founded a scholarship at this College, which was changed by the Council, subsequent to his death, into these pathological demonstrations, one of which we are holding to-day, as a tribute to his generous gifts both to the Museum and Library of the Royal College of Surgeons, a generosity made possible by his large fortune, which, it is interesting to note, he obtained by speculation in gas shares in the early part of the nineteenth century.

Erasmus Wilson was a great traveller and sojourned for a considerable period in the Middle East, whence at his own expense he had Cleopatra's Needle sent to London and erected at its present site on the Thames Embankment; those of you who have seen the solitary monolith of glistening granite, all that remains of the great temple of Heliopolis, rising above the maize fields on the outskirts of Materiah (also celebrated as a temporary dwelling-place of the Holy Family following their flight into Egypt) may doubt the wisdom of having removed from Egypt one of its many ancient monuments.

Erasmus Wilson, moreover, had a very forceful personality, and it was largely due to his obduracy, with the co-operation of the coroner (Wakely) the well-known Editor of the *Lancet*, that a verdict of death from flogging was brought in at an inquest on a soldier at Hounslow which led to a Parliamentary inquiry and to the subsequent abolition of flogging in the Services.

Some weeks ago an out-patient at the hospital brought from his doctor a note which read : " I have tapped this patient's hydrocele on two occasions and can obtain nothing but air ; , I am much mystified."

I mention this incident to remind you that it is essential to ascertain that any swelling in the scrotum is not a hernia or psoas abscess protruding through the inguinal canal from the abdomen.

It is a well-known fact that the majority of irritative lesions of the testis and epididymis result in the formation of a hydrocele in the tunica vaginalis, the presence of which masks the enlargement of the testicle or epididymis to palpation ; it is essential, therefore, in all cases where a hydrocele is present that this should be tapped in order that the testes may be palpated satisfactorily. This palpation may reveal the presence of enlargement of the testicle or the epididymis or both, and in many cases it may be most difficult to ascertain whether the enlargement is restricted to one or involving both organs. Palpation must not be restricted to the organs alone, but the whole length of the spermatic cord must be examined and especially the vas deferens to ascertain whether thickening of a uniform or localized nodular type is present here.

On this examination depends the accuracy of the diagnosis between inflammatory and neoplastic conditions, a diagnosis often of vital importance to the unfortunate patient and sometimes very difficult to make with accuracy. Furthermore, it is necessary that the lymphatic drainage of the testicle should be borne in mind ; it will be remembered that the testes develop in the retro-peritoneal tissues at the level of the first lumbar vertebra, and that the vascular supply and drainage eminate at this level in the adult. It is, therefore, in the para-aortic glands in the supra umbilical region that the lymphatic metastasis causes enlargement in all conditions affecting the testicle. Moreover, it is necessary to remember that the epididymis is closely applied to the scrotal integument posteriorly without any peritoneal sac intervening, so that any inflammatory condition of the *epididymis* will produce œdema at the back of the scrotum, a position where it is very likely to escape notice and ultimately, should suppuration occur, sinuses will develop through which secondary infection is very liable to gain entrance.

Traumatism

Tortion of the testes or, more accurately, tortion of the spermatic cord, is a condition which occasionally follows a sudden twist with the catching of the scrotum on the thigh, but is more frequently apparently spontaneous in origin and far more frequently seen in undescended testes, where a long rete testis and a lax cord predisposed to the onset of this condition. The whole testicle and epididymis are intensely congested and plum-coloured, and, although this venous congestion seldom causes actual gangrene of the organ, atrophy and fibrosis invariably follow, so that surgical removal on diagnosis is not only the most sensible and justifiable procedure, but saves the patient considerable pain and a tedious convalescence. It is needless for me to remind you that inadequate clinical observation and neglect to enquire into a history of acute intestinal obstruction may lead to a misdiagnosis of strangulated inguinal hernia in these cases.

I do not propose to deal with *wounds of the testes*, which, if they become infected, so often lead to the development of *Hernia Testes*.

Inflammatory Lesions

Acute inflammatory lesions of the testicle and epididymis are nearly always secondary to acute urethral infection and therefore the main and only stress of these infections falls on the epididymis which is enlarged, tender and painful, while at the same time it is a noteworthy fact that the urethral discharge tends to disappear temporarily so that the fact of its existence may escape notice unless a urethral swab is taken. The advent of chemotherapy has greatly modified the previously serious prognosis in these cases of acute epididymitis and the prompt administration of sufficient doses of penicillin or sulphonamide should not only prevent suppuration and rapidaly clear the local infection, but cure the primary urethritis also.

Mumps may cause a very severe and usually bilateral orchitis which tends to be followed by testicular atrophy and impotence. The salivary glands may or may not be enlarged in these cases and in some, undoubtedly, epididymitis occurs without any testicular enlargement, which may lead to misdiagnosis in the early stages.

Chronic inflammations may occur in the epididymis especially in young men undergoing strenuous physical exercise, as occurred in the armed forces during war, with the production of a localized painless thickening in some part of the epididymis usually, on one side only and with no other symptoms than possibly a little dull aching pain towards the end of a day's hard exercise. In such cases examination of the urethra and of the nodules themselves leads to negative bacterial results in the vast majority of cases, and one can only say that extensive research has failed to reveal the ætiology of this condition. It is important to notice that though the cord may be somewhat thickened in these cases the vas is normal, and rectal examination reveals no prostatic nodulation, so that the condition should never be mistaken for tuberculous epididymitis.

Tuberculous epididymitis is a condition seen not infrequently in young males, in about 50 per cent. of whom tubercle can be found in the urine or a tuberculous focus elsewhere in the genito-urinary tract, sometimes in the kidneys but more often in either the prostate or seminal vesicle. In these cases the epididymis is hard and craggy and the vas nodular and beady. A small hydrocele is often present and the testicle, though apparently normal, often reveals small tubercules near the hilum on careful examination. Caseation, and liquefaction with tuberculous abscess formation, occur early in these cases, and the material so formed is usually dead white in colour. In these cases the prognosis is notoriously bad, some 60 per cent. of the patients developing infection in the other epididymis within 18 months, whatever line of treatment is carried out in dealing with the original infection.

Syphilitic epididymitis. In the secondary stages of syphilis a diffuse and often bilateral thickening of both epididymes is by no means uncommon, though it often escapes notice because of its painlessness. As in all syphilitic infections of similar organs, the one side is usually infected 3-6 weeks before the other side manifests signs of infection.

Gummatous Orchitis. In the tertiary stages of syphilis a *localized gumma* may appear in the testicle where it causes a painless enlargement, usually with a small lax hydrocele which rapidly becomes obliterated as the gumma invades the scrotal tissues anteriorly and ultimately breaks down to form an obvious and typical gummatous ulcer on the anterior scrotal wall. Secondary infection usually occurs rapidly with sloughing of the fibrotic testicle. The caseous material is usually yellowish-white in colour in contradistinction to the white pus in tuberculosis and the sinus situated anteriorly on the scrotal wall.

A diffuse gummatous infiltration affecting first one and subsequently both testicles is quite frequently seen, and in these cases again the epididymis is often affected in the later stages, while a lax hydrocele partly masks the smooth and massive enlargement of the testes. Sinus formation is uncommon but the insensitive testes gradually diminish in size until they are represented by two small fibrotic nodules. Needless to say impotence accompanies these changes. The testicular substance can be detected amongst fibrous strata which give the appearance that the organ is being viewed through a sheet of ground glass.

In tropical and semi-tropical countries, both *frambœsia* and *bilharzia* give rise to thickening and granulomatous deposit both in the testes, epididymis and scrotal tissues, but these conditions are seldom seen in this country except among those who have sojourned in the tropics and have had the misfortune to have been infected in the countries in which they have been working. *Leprosy* may also occasion a painless enlargement of both testicle and epididymis, which often escapes notice among the more obvious signs of this distressing malady.

Testicular Tumours

It is often very difficult to diagnose between tumours and inflammatory conditions of the testicle, but in the majority of cases a rapid development and the presence of hæmatocele are indications that a tumour is present; though this may start quite frequently in the testicle, epididymal commencement is not unknown by any means and may lead to misdiagnosis in the early stages, with disastrous consequences to the unfortunate patient. If in doubt on clinical grounds as to whether a given testicular enlargement is inflammatory or neoplastic it is far safer, for the patient, to remove the infected organ, for, as you well know, early metastases, blood-borne and lymphatic, are of frequent occurrence in both teratomata, seminomata, and the rarer tumours, chorionepithelioma and hypernephroma which may be met with in this situation.

Simple Tumours

Lipoma, fibroma, and, more often, *fibro-lipoma* are of rare occurrence and seem to commence in the rete testis, usually in old men, and are frequently bilateral; they may reach considerable size, having been known to be between 2 and 3 pounds in weight.

Malignant Tumours

Malignant tumours of the testicle are by no means uncommon and occur usually between the ages of 18 and 30 years. They are commonly unilateral, disseminate rapidly by both the lymph and blood stream irrespective of their type and have, therefore, an extremely poor prognosis, the usual time of survival being 9-15 months. It is, however, of interest to note that should a patient have survived removal of the primary tumour a year without obvious secondary deposits being present, the prognosis is apparently quite good, as in my experience I have come across three or four such cases who are still alive and well from 10-40 years after removal of a microscopically established malignant neoplasm of the testicle.

Teratomata (fibro-cystic disease of the older surgeons) occur at any age from 15-35 but are commoner in the early twenties. Such tumours may contain all types of connective tissue and epithelial elements and are frequently present as a small tumour for a considerable period before one or other of the tissues contained in them undergoes malignant metaplasia with rapid increase in the size of the tumour which metastasises quickly.

Seminoma occurs usually as a solid vascular tumour arising from the epithelium of the seminiferous tubules and most frequently in the late twenties. The tumour usually grows rapidly and disseminates widely throughout the body, death frequently occurring from cerebral metastases. These seminomata and their secondary deposits react well to X-ray therapy but tend to recur rapidly.

Chorionepithelioma and *hypernephroma* may occur at any age and present the usual characteristics of these tumours when they occur elsewhere.

Sarcoma may occur as a tumour *ab initio,* but is more frequently the result of malignant changes in the connective tissue elements of a teratoma. Either form is extremely uncommon.

THE SURGERY OF THE SPINAL CORD

Lecture delivered at the Royal College of Surgeons of England
on
17th March, 1948
by

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THE SURGERY OF the spinal cord began on June 9th, 1887, when Sir Victor Horsley at Queen Square removed an intrathecal extramedullary tumour from the upper thoracic region of an Army officer aged 42 who was paraplegic and incontinent. The patient made a complete recovery and a year later wrote to Horsley that he was hunting. He remained well up to the time of his death from another cause, some 20 years later. The tumour was described as a myxoma which was in part cystic, which suggests that to-day we should almost certainly classify it as a neurinoma. Unfortunately this is not capable of verification as it (specimen 5063-1) was destroyed on May 10th, 1941, when the museum of this College was hit by a high explosive bomb.

Tumours perhaps should have first place in any consideration of the surgery of the spinal cord because their removal, if undertaken before conduction has been destroyed by prolonged compression, produces some of the most gratifying results in surgery. Many spinal cord tumours are fortunately extramedullary and capable of complete removal, and when so removed only very rarely recur (Fig. 1.).
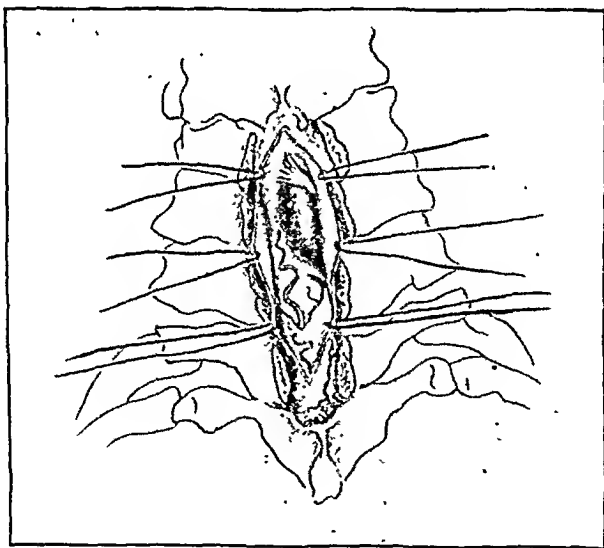

Fig. 1. An intrathecal extramedullary spinal cord tumour in the mid cervical region. The tumour can be seen lying undisturbed in its bed to the right and slightly behind the cord which it displaces and compresses and crossed by a posterior nerve root. The tumour was a neurinoma.

They tend to lie on the back or at the sides, rather than in front of the cord, and are either neurinomas arising from the nerve roots or meningiomas taking origin from the coverings of the cord. Their localisation by neurology and myelography and their removal by laminectomy are of almost everyday occurrence, but in the past they have at times been overlooked under a mistaken diagnosis of disseminated sclerosis or spastic paraplegia due to some system disease of the cord. It is important to regard every case of spastic paraplegia as possibly due to a spinal cord tumour until proved otherwise. Investigation of the subarachnoid space to determine the presence or absence of "spinal block" should be carried out in all doubtful cases. Some idea of the frequency with which these intrathecal extramedullary tumours occur may be gathered from the fact that quite recently and in as many weeks I have removed four of them, one from the cervical region (neurinoma), two from the thoracic (both meningiomas) and one from the cauda equina (neurinoma).

Spinal block. The presence or absence of "spinal block" is determined by performing lumbar manometry and testing for the Queckenstedt phenomenon, its absence or modification ; by the chemical and cytological examination of the fluid from the lumbar pond, and by myelography.

Injuries of the cord rarely call for surgery but foreign bodies or depressed laminæ may require removal if the subarachnoid space is encroached upon. For the commoner fracture-dislocation in which the cord is injured, there is unfortunately little that can be done by surgery. Any effort is like closing the stable door after the horse has gone, since the damage to the cord is produced suddenly as a nip by a to and fro movement, and by the time the patient comes under treatment recoil has occurred. Only rarely is there any sustained compression which the presence of "spinal block" will indicate and laminectomy relieve.

Division of tracts. In 1911, W. G. Spiller of Philadelphia observed a patient who had completely lost pain and temperature sensations in the lower limbs and at autopsy was found to have had each antero-lateral tract destroyed by a solitary tubercle. He suggested that this tract might be divided for the relief of pain. The operation was first performed by Edward Martin at the level of the 7th dorsal vertebra, and a year later Spiller regarded the result as successful.

Chordotomy (a term first used by Schüller of Vienna) has now been performed many times, not only for the relief of pain in inoperable malignant disease or in the case of causalgia or phantom limb, but also for the division of other tracts in the cord, such as the extrapyramidal descending fibres, e.g. rubro-spinal, in an attempt to relieve spasticity (Spiegel, 1924) and paralysis agitans or athetosis (Putnam, 1931, 1940). The only one of these tract sections which has proved really satisfactory, however, is division of the pain fibres (Figs. 2 and 3), and even in some of these cases a return of pain has occurred probably because of incomplete section of the tract. In cases of low pelvic pain it is necessary to make the incision in

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·the cord as far posteriorly as the attachment of the dentate ligament as failure to do so may leave some of the pain fibres from the pelvis undivided. Edgar A. Kahn and Max Pect (1948) have recently drawn attention to the necessity of extending the incision well forwards, further forwards than has been customary with some surgeons.

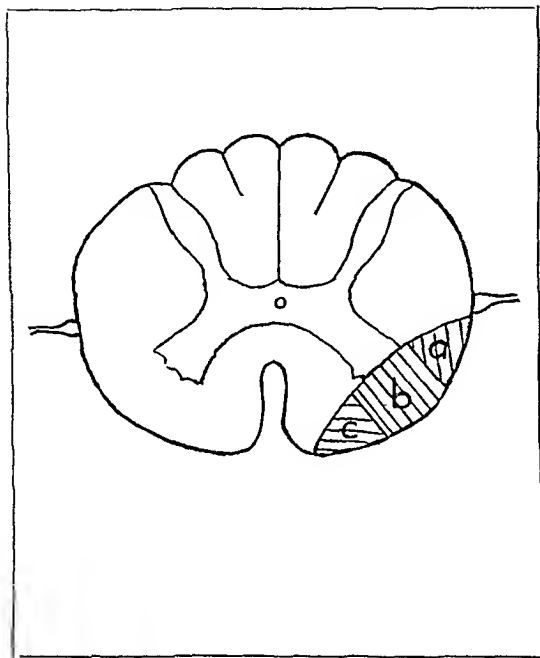*Syringomyelia.* Surgery has not much to offer for this condition and for the most part has proved disappointing except in occasional cases in which

Fig. 2. Chordotomy. The shaded area represents the position of the antero-lateral ascending tract, (*a*) fibres from legs; (*b*) from lower part of trunk; (*c*) from upper part of trunk. The attachment of the dentate ligament is shown.
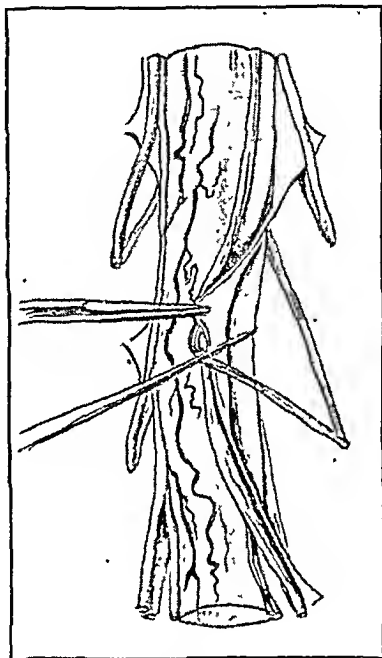
Fig. 3. Chordotomy. The cord is rotated by gently drawing on a detached slip of the ligamentum denticulatum. The knife is entered in front of the pial attachment of the ligament and in front therefore of the crossed pyramidal tract.

there has been " spinal block " as shown by investigation of the subarachnoid space, when an incision into the cysts by relieving compression has effected some slight improvement.

Other cases of cord compression. Occasional causes of cord compression for which laminectomy may be called are some cases of Paget's disease. I have had a successful case in which paraplegia was relieved and the patient, a man, aged 61, returned to work and for the past eight years has remained well, except for the disease elsewhere in the skeleton.

Other varieties of tumour than the two common intrathecal and extramedullary types, viz., the meningiomas and the neurinomas which have already been mentioned, are lipomas, both intra- and extrathecal and intra-

medullary tumours of different varieties, usually gliomas. Varicosities of the pial veins may be exposed as a cause of the cord lesion and if so are usually best left alone. Extradural tumours of various kinds such as osteomas and metastases, e.g. from the thyroid or testis, may be the cause of compression and likewise hydatid cysts, (which are almost always extradural). Abscesses and tuberculomas are occassional causes of cord compression, while a fortunately infrequent but troublesome cause of interference with function in the cord is the chronic spinal meningitis of Horsley (meningitis circumscripta serosa).

Laminectomy. Precise localisation of the level of the cord lesion may be obtained by myelography and is usually advisable as the level ascertained by clinical examination alone may be misleading.
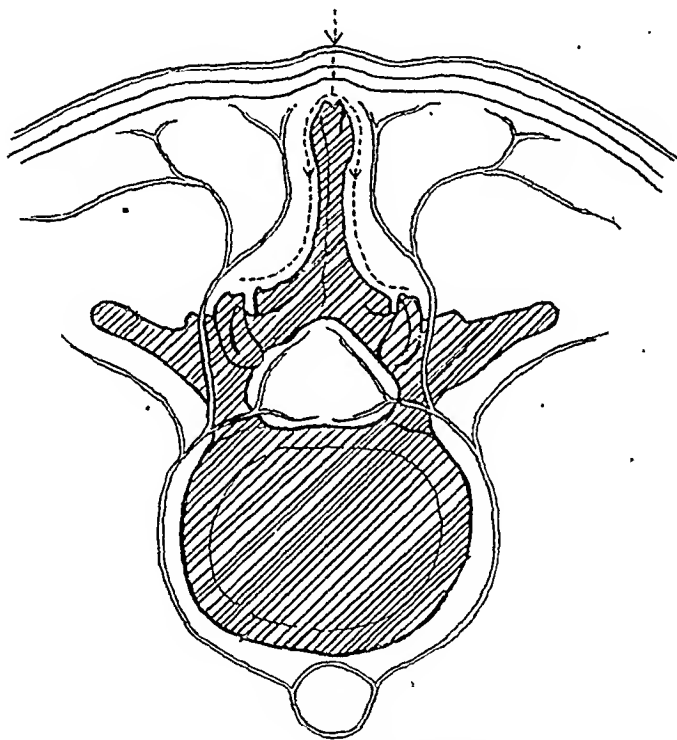
Fig. 4. Laminectomy is best performed through a longitudinal incision over the spinous processes. Flap types of incision are to be avoided. The muscle masses are detached close to the bone (along the dotted lines) to avoid their blood supply.

The operation is best performed with the patient fully prone, the chest being supported by shoulder rests so that it is clear of the table and the part of the spine to be operated upon flexed as much as possible. A longitudinal incision along the line of spinous processes is the best method of approach (Fig. 4).

The flap type of operation through a curved incision is to be avoided as the blood supply of the skin of the back is not very rich and only in the

case of the longitudinal incision over the spinous processes is it maximal for each side of the wound. The erector spinæ muscle masses are turned out of the post-vertebral grooves subperiosteally, and self-retaining retractors inserted; the necessary number of spinous processes are then removed and the laminæ also as far laterally as the articular processes on either side. In removing the neural arches a good deal of force may be necessary and it must be remembered that this must at all times be directed outwards and backwards away from the cord. The epidural fat is now exposed overlying the dura mater. The fat is gently wiped away and the dura opened after introducing a series of sling or guy sutures of fine silk wherewith to retract its edges.

It is sometimes possible to open the dura and leave the arachnoid intact in which case a beautiful view is obtained through the transparent membrane of the cord bathed by the cerebro-spinal fluid. The lesion, e.g. a tumour, may then be apparent; in any case the state of the posterior spinal veins may be observed (Fig. 1). If it is remembered that the blood flow in these is upwards, it will be apparent that if these veins are congested, the lesion is higher up the cord; if collapsed at a lower level than the area exposed.

Anteriorily placed lesions. If it is necessary to explore the front of the cord to deal with a tumour placed there or to divide the spino-thalamic tract which lies entirely anterior to the attachment of the dentate ligament to the cord, a slip of this ligament is detached at its dural end and by holding it in a fine pair of mosquito artery forceps the cord is gently rotated so as to expose its antero-lateral surface (Fig. 3). Specially designed knives are useful for division of the fibre tracts.

If an intra-thecal tumour is attached to the overlying membranes as are the meningiomas, the area of attachment of these membranes should be removed along with the tumour so as to minimise the liability to local recurrence. It is not absolutely necessary to close the dura if the muscle and aponeurotic layers are securely sutured, but the dura may with advantage be closed with fine silk, any defect in it being remedied by a sheet of one of the fibrin products.

Intervertebral Disc Lesions

Cord or root compression may be caused by herniated nuclear material from an intervertebral disc, particularly in the lower cervical and the lower lumbar regions. Root lesions are more commonly produced by extruded nuclear material than cord compression because of the protection afforded by the posterior longitudinal ligament (Fig. 5). While it is possible to remove the extruded material and free an involved root by means of a small opening made through the ligamentum subflavum, to one side of a spinous process, it should be remembered that surgery performed through small openings is usually bad surgery. Adequate exposure is always desirable and even an extensive laminectomy, if carefully performed so as not to damage the retracted erector spinæ muscles or the articular processes, does not weaken the spine.
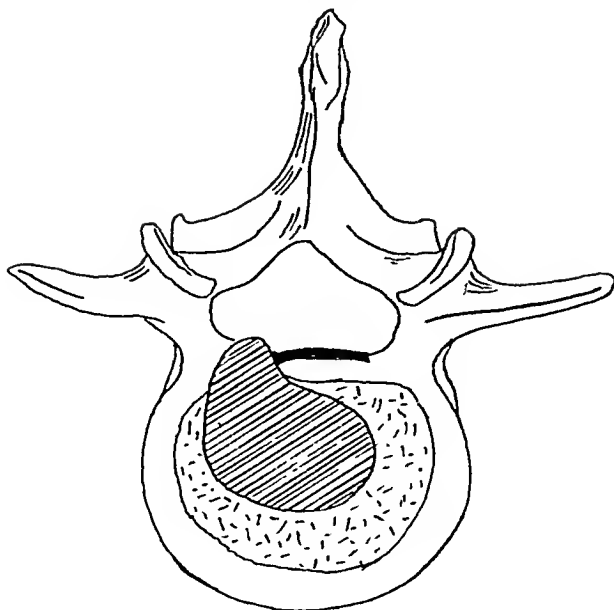
Fig. 5. Diagrammatic sketch to show how a nuclear protrusion tends to involve the issuing nerve root rather than the cord. The posterior common ligament prevents a more central extrusion from taking place.

Although regeneration never takes place in the human cord once it is divided, it is surprising to what an extent the cord may be flattened by a tumour and to what an astonishing degree it will regain its function after the relief of such compression, particularly if the patient is young. I have seen the cord literally looking like a piece of tape at the site of compression by a tumour in a young woman with paraplegia and incontinence who after removal of the tumour, nevertheless, made a complete recovery, regaining both the full use of her legs and control of her sphincters.

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THE ANATOMY OF THE LYMPHATIC DRAINAGE OF THE VULVA AND ITS INFLUENCE ON THE RADICAL OPERATION FOR CARCINOMA

Hunterian Lecture delivered at the Royal College of Surgeons of England
on
13th February, 1948
by
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CARCINOMA OF THE VULVA has proved extremely obstinate to the radio-therapist. The enormous numbers of end arteries and the very poor collateral circulation which it possesses coupled with the atrophic conditions which frequently accompany carcinoma leads with extreme frequency to radium necrosis. In addition, and this is perhaps not widely recognized, most carcinomas of the vulva show a considerable degree of radio-resistance. The vulva is therefore an unsuitable situation in which to employ radio-therapeutic measures in the treatment of carcinoma.

Very few organs in the body are provided with such a rich lymphatic drainage or with such a surgically accessible lymphatic drainage and the spread of cancer in fairly early stages to these lymphatics occurs in more than half the cases which are encountered. For these reasons it remains to-day as it did thirty years ago one of the most ideal sites for a radical surgical attack when it is the seat of a carcinoma. If, however, one reviews the results of surgical treatment they are in the hands of all but a few surgeons very poor, and if one goes further and studies the methods employed by the majority, the reasons for this failure are obvious. Most of the operations performed are based either on an incorrect knowledge of the lymphatic anatomy or on apparently no knowledge at all. They are houses built upon sand in which the tenant and not the builder meets with inevitable disaster. We must therefore build our house upon rock and that rock consists of an accurate knowledge of the pathological anatomy of the lymphatic drainage.

The Structure and Function of Lymphatics

Before considering the details of the vulval lymphatic anatomy it is as well to consider briefly the structure and function of lymphatics in general. The chief function of the lymphatic system in man is the return of blood proteins to the blood stream (Drinker & Yoffey 1941), and its origin in mammals is probably by budding from the venous system, but this is a matter concerning which there are long-standing and unsettled differences of opinion.

The lymphatic capillaries are closed networks without valves and with extremely free inter-communications. Their walls consist of endothelial

plates whose sole function is to retain lymph. Mucous membranes, like the inner aspect of the vulva, are particularly rich in these capillaries. The capillaries join together to form lymphatic trunks which are provided with valves. The walls of these trunks are contractile containing smooth muscle which is abundantly supplied by nerves. Lymph nodes consist essentially of a mass of free cells mostly lymphocytes with a supporting framework of reticulum cells and fibrous and elastic elements. An interesting transition in the arrangement of nodes takes place in the higher animal where several groups of small nodes interrupt the lymph flow as compared with one large one in the lower animal such as a cat or dog.

The afferent vessels entering a node go first to the cortical sinus, then through the medullary sinuses to the efferents at the hilum and from there to the next group of nodes. Since the structure of the nodes is extremely fine and intricate they form very efficient filters capable of holding up structures larger than 2 μ. in diameter and their function appears to be one of separation of unwanted elements which might be returned from the tissue spaces to the blood stream. It is fairly certain that the lymph may by-pass one or more nodes in a given group but as Yoffey & Drinker (1938) have pointed out they never by-pass a complete group of nodes and they conclude that it is impossible for lymph to reach the blood stream without traversing at least one node.

Although it has been suggested notably by Bayer (1885) that lymph nodes can regenerate after surgical excision the present view is that this never occurs, but neighbouring nodes in a group may hypertrophy when some of the nodes of that group are removed. On the other hand the lymphatic channels themselves can regenerate very quickly as has been shown by Reichert (1926) in Halstead's Laboratory at Johns Hopkins.

The Groups of Lymphatics Draining the Vulva

The lymph nodes associated with the drainage of the vulva can be divided into five main groups :

1. *The superficial inguinal nodes* (Fig. 1). These lie along the line of the inguinal ligament and slightly below it. There are anything from 12 to 20 of these nodes and they tend to be arranged in two groups, the lateral of which is an elongated chain, whilst the medial nodes lie clustered together just inferior to the superficial ring.

2. *The deep inguinal nodes*, are about four in number and lie in the inguinal canal along the course of the round ligament. They are inconstant.

3. *The sub-inguinal or superficial femoral nodes* are grouped round the great saphenous vein just before it passes through the fossa ovalis to join the femoral vein. They are divided into a medial group which is the larger and is situated near the entry of the superficial circumflex iliac, the superficial epigastric and superficial external pudendal veins into the saphenous. The lateral group lies on the external side of the saphenous

vein. These nodes and the superficial inguinal nodes communicate freely with each other and are sometimes considered as one group divided into supero-lateral, supero-medial, infero-lateral and infero-medial sub groups. They are always present although their numbers are variable. The efferents from these nodes pass along the course of the femoral vessels to the *deep femoral nodes* (Fig. 2).
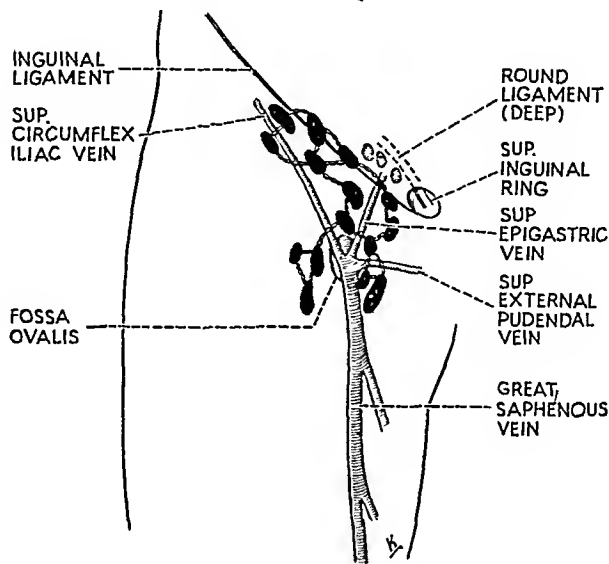

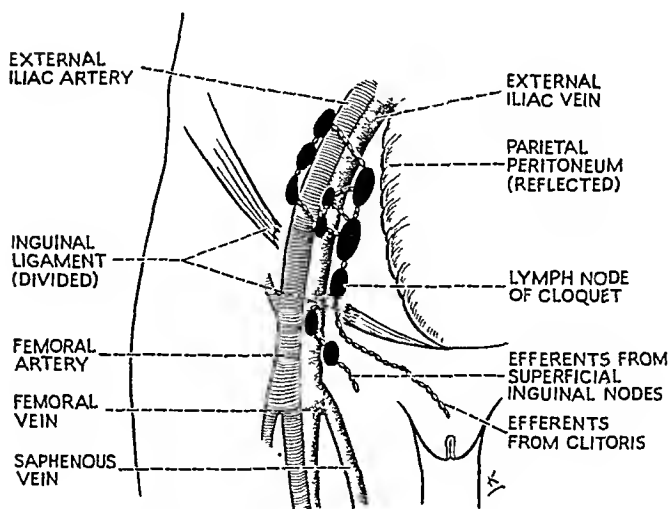Fig. 1. Dissection of Scarpa's triangle on the right side showing Superficial Inguinal and Sub-inguinal Lymph Nodes

Fig. 2. The Deep Lymphatic Drainage of the Vulva.

Most text books of anatomy give the number of these latter as three and describe their situation as lying between the femoral artery and vein

in the case of the lower two. I have dissected over 100 groins at operation and I have never seen them. When they do exist they are probably not true lymph nodes but the fusiform swellings that often occur at the anastomosis of several large lymphatics. The upper node of this group is very constant and is known as the *lymph node of Cloquet or Rosenmuller*.

Very few lymph nodes in the body are designated by men's names, so that I cannot resist telling you a little about these two surgeons. Jules Germain Cloquet was born in Paris on December 18th, 1790, and had a distinguished student career. He became Professor of Clinical Surgery in the University of Paris and devised many operative procedures and invented several surgical instruments. He is said to have excelled in making anatomical models in wax. He was a prolific writer, publishing works ranging from a text book of Human Anatomy in five volumes to a monograph on Lachrymation in Serpents. One of his earliest works and possibly one which brought him into contact with this lymph node was an account of his researches on hernia.

Johann Christian Rosenmuller was born on May 25th, 1771, and studied first at Leipzig where he graduated in 1792 and then at Erlangen, returning to Leipzig in 1794 as prosector at the Anatomical Institute. In 1802 he became Professor of Anatomy and Surgery at Leipzig and held this appointment until his death on February 28th, 1820, at the early age of 48. He wrote numerous works, mostly on anatomy and his connection with this lymph node may have dated from his extensive researches on the obturator nerve.

The node lies at the upper end of the femoral canal. It is usually described by the Anatomists as occupying the lower end, and may do so in the shrivelled preserved bodies which they dissect, but in the living this node lies high in the canal under cover of the inguinal ligament, and as Rentschler (1929) points out its upper pole projects into the pelvic cavity. It receives efferents from the superficial inguinal nodes and also directly from the clitoris and the upper part of the labia. In turn its efferents pass to the external iliac nodes. Through this gland passes almost all the lymph from the vulva. It is the focal point for the attack on the lymph spread of cancer.

The external iliac nodes lie in three groups. The lateral consists of a chain of small nodes lying on the lateral side of the external iliac artery. These nodes are mostly concerned with the flow of lymph from the lateral aspects of the leg and are only very rarely involved with carcinoma of the vulva. The anterior group are inconstant and when present are quite small and lie in the sulcus between the external iliac artery and vein. The medial group consists of a single chain of very large nodes up to about six in number which lie embedded in fat infero-medial to the external iliac vein. This infero-medial position is of some importance as it is necessary at operation to lift up the vein in order to expose them. To the uninitiated they may pass unnoticed despite their comparatively large

size. They receive afferents from the node of Cloquet and pass their own efferents to the common iliac nodes.

The presymphyseal lymph nodes are very small and lie in the fat in the lower part of the mons veneris usually around the root of the clitoris. They, are inconstant. Sometimes true lymphoid tissue is found in these situations although more often they are usually the dilated anastomoses of large collecting lymphatics associated with the enormous lymphatic anastomosis which takes place in the lower part of the mons. I have never encountered a case where these nodes have been palpable. In the male they appear to be more constant and are often palpable in cases of carcinoma of the penis.

The lymphatics of the vulva arise from an extremely fine and diffuse network which covers the entire vulva with the exception of the lateral surface of the labia majora, and this network is so profuse that if the vulval lymphatics are injected with mercury the entire vulva is converted into an ashen grey mass, from which the lymphatic channels are indistinguishable from one another even with a lens. This was clearly demonstrated by Sappy in 1874 and confirmed by Bruhns in 1896 and Cuneo and Marcelle in 1901.

On the external surface of the labia majora the lymphatics become much larger and the collecting trunks begin to form. These when injected can be distinguished by the naked eye. The collecting trunks vary in their course according to. the part of the vulva from which they originate. Those from the posterior part run transversely towards the superficial inguinal nodes whilst those from the anterior portion run upwards on to the mons veneris and then turn laterally also to reach the superficial inguinal nodes. There is one exception to this general arrangement and that is in the case of some of the lymphatics of the clitoris which run directly from that organ to the lymph node of Cloquet, and may by anastomosis take some of the lymph drainage of the upper part of the labia with them.

Now the vulva is a bilateral organ joined anteriorly and posteriorly in its midline and thus it comes about that the lymphatics of both sides anastomose and in some cases the collecting trunks of one side reach the nodes on the opposite side. This observation is of vital importance because it shows the possibility of the contra-lateral spread of carcinoma. It is also obvious that tumours occurring in the midline either at the clitoris or the fourchette may metastasise simultaneously to the nodes of both sides.

One other observation concerned with anatomy must be mentioned. The medial aspect of the labia merge with the lower end of the vagina at the hymen. Some of the lymphatics of the lower third of the vagina run directly to the external iliac nodes and this explains the frequent observation that when a carcinoma of the vulva, no matter how small, involves the lower end of the vagina the prognosis is very much worse than when this latter structure is not involved. In one of my cases I was

able to demonstrate quite clearly continuous lymphatic permeation of growth from a primary involving the lower end of the vagina to the medial group of external iliac nodes which were found at operation to be fixed and inoperable. There was in this case only a short history and the local tumour was not very extensive.

The Mode of Invasion of Lymphatics by Vulval Cancer

The cause of lymphatic metastases is unknown but would appear to depend on some biophysical or biochemical property of the tumour cells themselves. Even in the same histological groups there appears to be considerable differences among the tumours in their tendency to metastasise. I have seen a squamous carcinoma of the vulva which was known to have existed for ten years and to have destroyed the entire vulva, yet the nodes on section showed no evidence of secondary deposits. On the other hand I have seen one tumour which presented with breaking down nodes in the groin associated with a primary that was only just visible to the naked eye.

About the method of spread there is little doubt. It is in the vast majority of cases by embolus and not by permeation. Willis (1934), in his excellent book on the spread of tumours in the human body states:—" It is common knowledge that local recurrence, following the removal of primary growths of the breast, tongue, lips, vulva, etc., occurs either at the site of the primary growth or in the lymph nodes ; recurrences at intermediate sites along the course of the lymphatic vessels are rarely observed. Many workers have examined tissues intervening between the primary and their early lymph node metastases and have failed to find tumour in the connecting lymphatics."

In the 130 cases of carcinoma of the vulva that I have seen in the last ten years these views of Willis are almost entirely substantiated. There were two cases however, in which direct permeation was seen. Willis believes that lymphatic permeation occurs only in the immediate vicinity of the tumour. There were in my series ten examples of the so-called " kissing ulcer " or " implant secondary." Five of these showed lymphatic permeation from one " primary " to the other, and in three of the five others there were more than two primaries present at the same time. I have found nothing to support the theory of contact implant and I believe that they are either individual primaries or local lymph-borne metastases. The frequency and distribution of nodal metastases is of great importance and although the frequency depends on factors unknown, the distribution is entirely dependent on the anatomical configuration of the lymphatics. I would like at this stage to recapitulate briefly the important points in the anatomy of the lymphatic drainage (Fig. 3). Firstly, most of the vulva drains directly to the superficial inguinal and sub-inguinal groups of nodes and from there to the node of Cloquet and thence to the external iliac nodes. Certain lymph trunks from the clitoris and upper end of the labia drain directly to the node of Cloquet,

and the lower end of the vagina drains directly into the external iliac nodes.

Secondly, some lymph trunks end in the nodes of the opposite side and thirdly, there is a very big lymphatic anastomosis in the mons veneris.
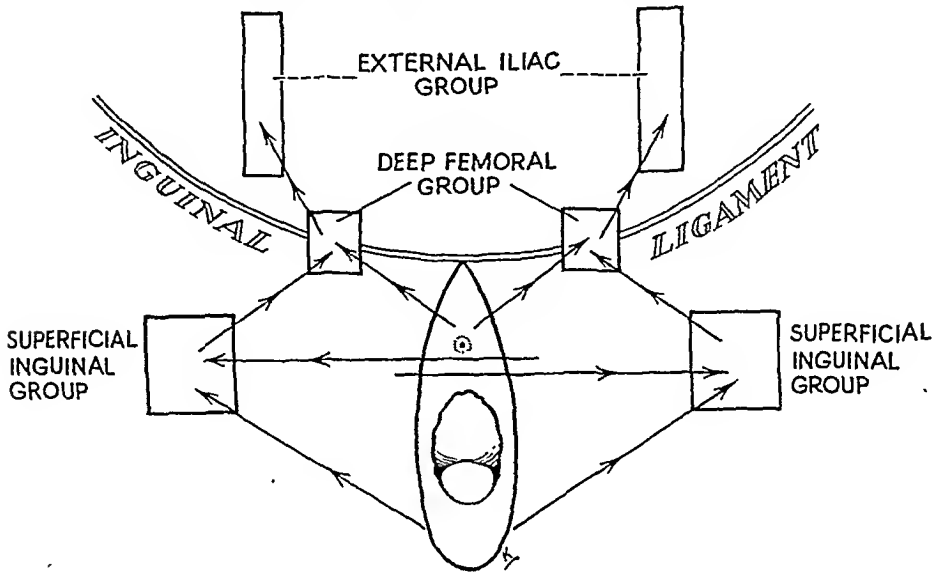

Fig. 3. Schematic representation of the mode of lymphatic spread of vulval cancer.

TABLE 1

INCIDENCE AND SITE OF NODAL INVOLVEMENT

Gross Analysis

Total number of cases	..	..	..	84
Lymph nodes not involved ..		..	..	40
Lymph nodes involved	..	..	..	44

The frequency with which I have been able to demonstrate histological lymph node involvement is quite in keeping with the figures published by other workers. Table 1 shows that out of 84 cases studied histologically the nodes were found to be involved in 44 and not involved in 40. In three out of 42 of these cases in which the deep nodes were studied, they were found to be involved and superficial ones were free.

Of more interest and of greater importance is the incidence of bilateral and contralateral node involvement. In Table 2 we see the findings in 33 cases in which the tumour occupied with right side of the vulva. Twenty-nine were on the labium majus and four on the labium minus. Contralateral gland involvement occurred in one case, bilateral involvement in two, and in five cases a unilateral dissection only was performed and the state of the nodes on the opposite side was not determined histologically at the time

of operation although in one patient two months later there were fungating nodes in the left groin. In all these five cases the nodes on the right side were involved.

TABLE 2

INCIDENCE AND SITE ACCORDING TO SITUATION OF PRIMARY

Right Side

Total cases	33
Nodes not involved	19
Nodes involved on left	1
Nodes involved on right	6
Nodes involved on right and left	2
Nodes involved and information incomplete	5

There were 27 tumours on the left side of the vulva, 23 on the labium majus and four on the labium minus and the incidence of nodal involvement is shown in Table 3. There was contralateral involvement in one and bilateral in eight. There was a larger incidence of nodal involvement in tumours occurring on the left labia than on the right, but both series are small and I do not think that this observation has any statistical significance.

TABLE 3

INCIDENCE AND SITE ACCORDING TO SITUATION OF PRIMARY

Left Side

Total cases	27
Nodes not involved	11
Nodes involved on left	7
Nodes involved on right	1
Nodes involved on right and left	8

Table 4 shows the findings in 24 midline and bilateral tumours, includin one on the perineum and 13 on the clitoris. In seven cases only a unilateral dissection was carried out and information was incomplete except that the nodes on the side dissected were involved. It is obvious from this study that a dissection of one groin only or simple removal of the vulva has no rational basis.

TABLE 4

INCIDENCE AND SITE ACCORDING TO SITUATION OF PRIMARY

Midline and Bilateral Cases

Total cases	24
Nodes not involved	10
Nodes involved on left	1
Nodes involved on right	0
Nodes involved on right and left	6
Nodes involved and information incomplete	7

Pre-malignant Lesions of the Vulva

To the late Comyns Berkeley and to Victor Bonney we owe a debt for bringing into prominence the fact that leucoplakia is a pre-malignant condition. In 78 per cent. of my cases this lesion was present in association with carcinoma. On seven occasions I have seen second primaries develop in residual areas of leucoplakia, and it has a very important bearing on the extent of tissue to be removed at the radical operation. It is essential that all the leucoplakic tissue should be widely removed. It is useless trying to leave tissue in order to sew up the vulval wound. This will inevitably lead to a recurrence of the leucoplakia and the possibility of fresh primaries. We have seen that new lymphatic channels will form quickly in the reconstructed vulva and if the nodes have been removed new and bizarre routes of spread of the tumour may take place. It is thus vital to remove all the leucoplakic bearing area even if it means sacrificing enormous amounts of skin, and in 78 operations for vulval carcinoma of various types that I have performed in the last ten years, I have always insisted on this procedure and I have yet to encounter a local recurrence.

Leucoplakia is a fascinating disease occurring mostly, but not always, after the menopause. It occurs in a limited area from the root of the clitoris round the labia sometimes into the labio-crural fold, on to the perineum, around and on the anal skin, and then into the natal cleft in an ever narrowing area until it reaches an apex over the third piece of the sacrum and it is always confined to this area. I think I may have been the first person to point out that this area corresponds almost exactly to the area of sexual skin seen in the baboon. The changes in the sexual skin of the ape due to endocrine factors have been well studied by Zuckermann and there seems little doubt that there is endocrine control of this area in women. Leucoplakia when seen before the menopause is almost always associated with menstrual dysfunction. It is made worse symptomatically by pregnancy and the area in which it occurs pigments heavily in pregnancy in brunettes and to a less extent in blondes. It is a strange feature that all the carcinomas that arise in areas of leucoplakia do so in the anterior two-thirds of this area of sexual skin. There are evolutionary and embryological differences, however, between the anterior two-thirds and posterior one-third of this area.

In addition to leucoplakia I found in our series cancer supervening in a syphilitic lesion in two cases and in lupus in one case. There were probably more examples but the records of forty years ago are very incomplete and histological proof could be found only in these three examples.

A Review of the Methods and Results of Various Treatments of Carcinoma of the Vulva

A multiplicity of surgical methods have been employed in the treatment of this disease ranging from local excision of the tumour to the combined

intra- and extra-peritoneal operation of Kehrer. Few really large series of cases have been published. The methods may be divided into three main groups :—

1. Local excision of the vulva or the tumour itself.
2. Removal of the vulva with the superficial nodes of one side.
3. Removal of the vulva with the superficial nodes of both sides.

The results of these operations have not been striking and the communication of Blair Bell and Datnow (1936) which incidentally is the only reasonably large series recorded in this country, shows a five-year survival rate of 33 per cent.

A review of the results obtained in Newcastle between 1908 and 1943 are no better. Simple vulvectomy cannot be expected to produce satisfactory results if as we have seen the nodes are involved in more than half the cases. The surprising fact is that as will be seen from Table 5, 21 patients lived five years. It is known that four of these died, one with metastases and three with local recurrence or fresh primaries between the fifth and tenth years.

TABLE 5

RESULTS OF TREATMENT

Simple Vulvectomy and Local Excision of Tumour

	Cases	
Total	87	
Primary Deaths	3	(3·3 per cent.)
Recurrence within one year and subsequent radical surgery	2	
Died before three years ·	48	(55 per cent.)
Three-year survivals	25	(28 per cent.)
Five-year survivals	21	(24 per cent.)
Ten-year survivals	9	(10 per cent.)
Untraced	10·	

Diathermy coagulation was introduced by Elis Berven at the Radium-hemmet in Stockholm and in his hands has given 36·7 per cent. five-year cures (Berven E., 1941). His method consists of destroying the vulva and a wide area around it by diathermy coagulation and the nodes are treated by teleradium with excision in cases in which clinical examination indicates involvement. On the question of the reliability of clinical examination I shall have more to say in a moment. In our series Berven's technique was not adhered to strictly and the results, as you will see from Table 6, are very bad. Excision of the vulva or half the vulva with the superficial nodes on one side (Table 7) gave no better results than local excision, in fact the figures are almost identical.

TABLE 6

RESULTS OF TREATMENT

Diathermy Coagulation

	Cases	
Total	41	
Primary Deaths	2	(5 per cent.)
Died before three years	30	(73 per cent.)
Three-year survivals	6	(15 per cent.)
Five-year survivals	4	(9·7 per cent.)
Survived nine years developed fresh primary (radical surgery)	1	
Ten-year survivals	3	(7·3 per cent.)
Untraced	3	

TABLE 7

RESULTS OF TREATMENT

Excision of Vulva or Hemivulvectomy and dissection of Glands on one side only

	Cases	
Total	13	
Primary Deaths	0	
Died before three years	6	(46 per cent.)
Three-year survivals	3	(23 per cent.)
Five-year survivals	3	(23 per cent.)
Ten-year survivals	2	(15 per cent.)
Untraced	4	

Excision of the vulva with superficial bilateral node dissection gave slightly improved results but when the superficial nodes were involved the results were bad (Table 8).

TABLE 8

RESULTS OF TREATMENT

Excision of Vulva with bilateral superficial Groin dissection

	Cases	
Total	23	
Primary Deaths	1	(4·3 per cent.)
Died before three years	13	(56 per cent.)
Three-year survivals	8	(35 per cent.)
Five-year survivals	5	(21 per cent.)
Ten-year survivals*	1	
Untraced	1	

*Three cases operated on less than ten years but more than five still alive without recurrence.

All node involved cases died before five years.

Was this then to be the final achievement of the surgical treatment of this disease ? With radiotherapy alone giving 11 to 13 per cent. five-year cures and with surgery giving somewhere in the region of 30 per cent. the outlook was bad for such an accessible disease. Apparently the proposed anatomical approach of Bassett who suggested bilateral removal of the nodes as far away as the lymph node of Cloquet was forgotten and the extraperitoneal approach to the iliac glands by Stoeckel and the intraperitoneal approach of Kehrer were done in only a few cases, although with encouraging results. It remained for Frederick Joseph Taussig of St. Louis to put the Bassett technique to its full test and his comparative results published in 1940 and shown in Table 9 will give some idea of the magnitude of his achievement.

TABLE 9

RESULTS OBTAINED BY F. J. TAUSSIG, ST. LOUIS, U.S.A.

	Cases	5-year survivals	
Double-sided Bassett with vulvectomy ..	41	24	(58·5 per cent.)
Superficial or one-sided adenectomy ..	21	6	(28·6 per cent.)
Vulvectomy only	12	1	(8·2 per cent.)
Radium (mostly advanced)	21	1	(4·8 per cent.)
Palliative measures	6	0	
Totals	101	32	(33 per cent.)
BASSETT OPERATION :			
Nodes involved	19	10	(52·6 per cent.)
Nodes not involved	22	14	(63·6 per cent.)

His publication came to me at a time of despondency concerning the treatment of carcinoma of the vulva and for two years feeling that the operative mortality would be very great I fell into a trap of which I think due warning should be given. I placed reliance as Berven has done on clinical examination of the groin nodes to tell me whether or not they were involved with cancer and for two years I modified my operations accordingly. Table 10 shows an analysis that I have subsequently made of the correlation between enlargement and histological findings.

TABLE 10

CLINICAL EVALUATION OF LYMPH NODE ENLARGEMENT

IN RELATION TO HISTOLOGICAL FINDINGS

	Histologically involved	Histologically not involved
Nodes enlarged	15	12
Nodes not enlarged	14	22

Only a few weeks ago I was asked by one of my radiotherapist colleagues to dissect the groin nodes in a patient who had had a vaginal carcinoma treated with radium. We both examined her and found enlarged hard

nodes in the right groin and no palpable nodes on the left. The right nodes were not themselves tender but she complained of a nagging pain in the right groin. We agreed that as far as clinical examination went the nodes of the right groin were probably involved but not those of the left. Nevertheless, since we were both aware of the findings in this table we assumed that we should probably be wrong. I performed a bilateral extended dissection and histological examination showed that the left nodes were involved but the right ones were not.

In addition to the figures shown in Table 10 there are 33 cases in whom there was no histology but from which certain deductions may reasonably be made. They fall into two groups. In the first group non-enlargement of the nodes was taken to indicate non-involvement with carcinoma and dissection of the nodes was not carried out, but despite control of the primary tumour they died with secondary involvement of the nodes. There were nineteen cases in this group. In the second group there were fourteen cases in whom non-enlargement of the nodes was taken to indicate non-involvement and who survived more than six years despite the fact that the nodes were not resected. The average survival was 10·7 years ; five died of intercurrent disease and nine are still living. Although one cannot be certain I feel that we may assume that the nodes in these cases were not involved. If we add these cases to the ones in Table 10, we find 36 cases in which non-enlargement was associated with no involvement of the nodes and 33 in which non-enlarged nodes were involved with growth. The microscope therefore is our only certain guide. I may add that except in very few cases serial sectioning of the lymph nodes was not carried out and as Taussig has pointed out if this were done a greater incidence of nodal involvement may be found. In two of his cases in which the nodes were thought to be free of cancer, serial sectioning showed that this was not the case. We cannot therefore rely on clinical evaluation of the groin nodes ; and I think it is clear that every case must be regarded as having involved nodes.

Looking back on our anatomical and pathological knowledge demonstrates that we require an operation which will remove the vulva very widely and include a removal of all the pre-malignant lesion ; which will remove the nodes up to and including the external iliacs on both sides and which will take away the lymphatic anastomosis situated in the mons veneris.

The operation which I now employ is the same in principle as that of Stoeckel, a little more extensive than that of Taussig but differing in certain details from both these operations. It is six years since I performed the first and in the intervening period I have performed 42 subsequent operations or one more than Taussig performed in 25 years, and in the last two years my operability rate has been 83 per cent. Thus I may be said to have passed through an experimental stage to a somewhat settled technique. Unfortunately there are certain details concerned with wound

healing that still baffle me and other workers in America and need perhaps a change in technique.

The Extended Radical Operation

I have always aimed at a one-stage resection *en bloc* and have only twice, on account of age or concomitant disease, performed a two-stage operation, and the technique that I employ is as follows :

The patient is premedicated with omnopon and scopolomine and spinal anæsthesia is always employed. The lymph nodes are attacked first. An incision is made from one anterior superior spine to the other across the top of the mons. A second incision starting at the same place passes downwards towards towards Scarpa's triangle and from there a small triangular extension is made over the course of the saphenous vein (Fig. 4).
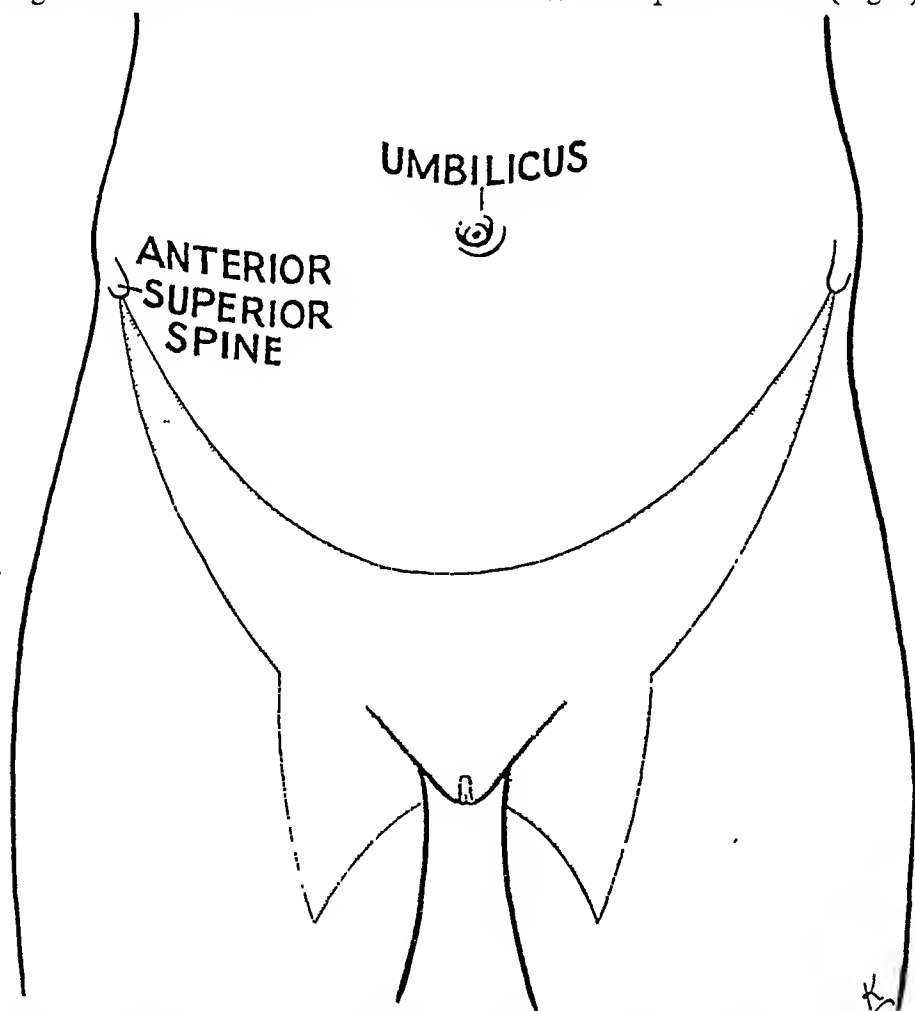
Fig. 4. Diagram illustrating Inguinal Incision for removal of Lymph Nodes in the Radical Operation for Carcinoma of the Vulva. (Shaded area shows amount of skin removed.)

Unlike Taussig I remove flaps of skin in this area. This considerably reduces necrosis in the wound and allows the superficial nodes to be removed completely, without having to scratch about for them in an area which may contain cancer cells very neatly tied up in lymph nodes. Why then break down the advantages that nature has conferred by the risk of cutting into these nodes ? I have operated on four patients who had previously had the superficial nodes removed by simple incision. In all I found nodes remaining and since, as we have seen, it is unlikely that they ever regenerate I can only conclude that they must have been left behind at the original operation. With my method this is not possible.

Having stripped the external oblique fascia and inguinal ligament bare, the saphenous vein is isolated and its tributaries ligated and divided and the sub-inguinal nodes mobilised. I have always attempted, if possible. to leave the saphenous vein intact as I believed that it reduced the tendency to lymphœdema. I am not now convinced that this is the case. The saphenous is followed into the femoral vein and it and the femoral artery are exposed and cleaned.

The inguinal canal is opened and the deep inguinal nodes and the extra-peritoneal portion of the round ligament mobilised. Care is needed here not to remove too much of the round ligament as otherwise the peritoneal cavity may be opened.

The transversalis muscle and fascia are next incised one inch above Poupart's ligament. ⋅If the incision is nearer to Poupart than this it is difficult to repair and in addition division of the deep circumflex artery is a certainty. This is not serious but is annoying and unnecessary. It is now possible to sweep the peritoneum medially and expose the external iliac vessels.

The deep epigastric vessels are now divided as near to the external iliacs as possible. A finger or hernia director is passed along the femoral canal and the inguinal ligament is divided and the cut ends reflected. The external iliac and femoral vessels are now exposed from the bifurcation of the common iliac to the apex of Scarpa's triangle and the deep lymph nodes are removed in one strip (Fig. 5). Just at the pelvic brim is a very constant vein which comes from the region of the obturator nerve and enters the external iliac vein at the level of the entry of the deep epigastric vein but on the medial side. It is usually well hidden in fat. I have found no record of it in the anatomy books and my first introduction to it was when I tore it off the external iliac vein. There is, as a rule, very little hæmorrhage associated with this part of the operation and if there is any doubt I always pack the wound with absorbable cellulose.
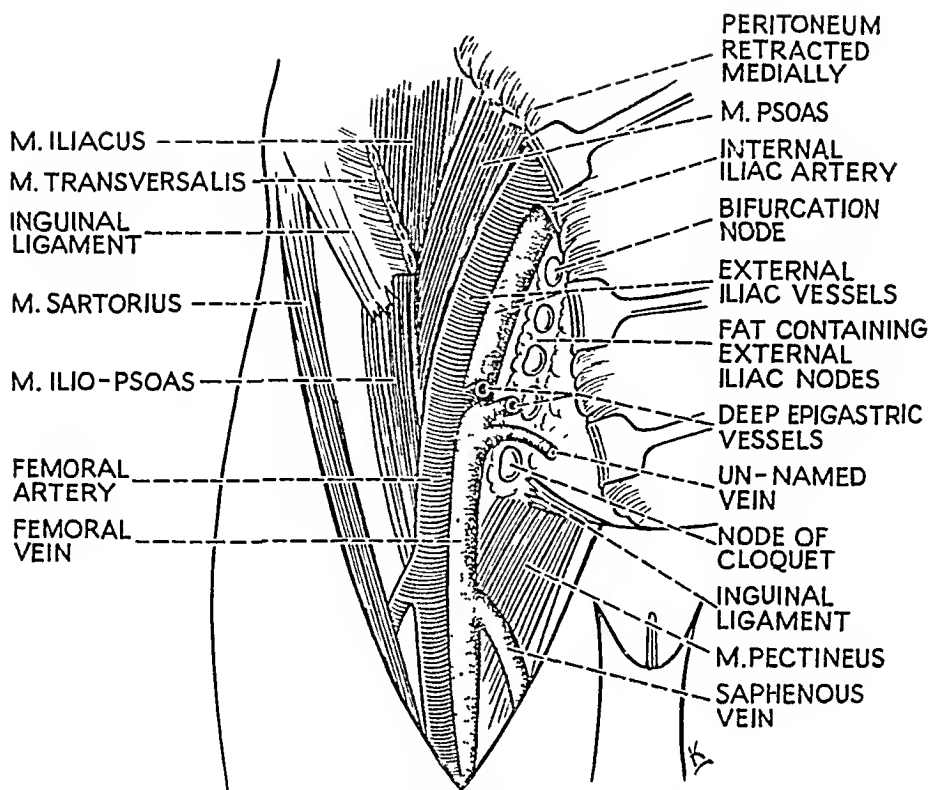
Fig. 5. Diagram illustrating exposure of the Deep Femoral and External Iliac Lymph Nodes in the Radical operation for Carcinoma of the Vulva.

The wisdom of removing the external iliac nodes has been questioned. Now the node of Cloquet must be removed and much the same dissection is required to expose the iliac nodes. It takes only a few minutes longer to remove the higher nodes. The aim of any such operation should be to remove all the affected groups of nodes and the *next group beyond them*. It has also been suggested that if these nodes are involved the patient will inevitably be lost. In my series there were three such cases. In two they were fixed and their removal was incomplete. One died of operation and the other three months later. The third patient died in nine months of spinal metastases and metastases in the head of the left humerus. This is very uncommon in cancer of the vulva. In Taussig's series there were also three such cases. They were at the time of his last writing surviving operation by nine, eleven and sixteen years.

The transversalis muscle and fascia are resutured, the external oblique closed and the inguinal canal obliterated. Usually the inguinal ligament cannot be repaired and the femoral canal is closed by suturing the external oblique fascia to the pectineus or by cutting autogenous grafts of external oblique to close the deficiency (Fig. 6).
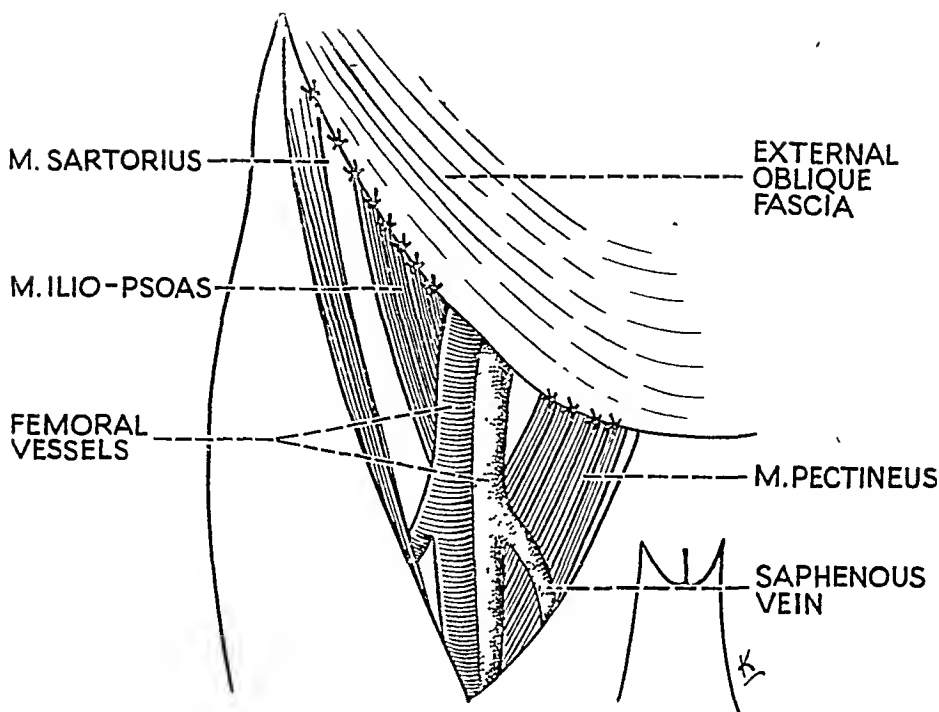
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Fig. 6.   Diagram illustrating repair of Abdominal Wall
and closure of Femoral Canal.

I am indebted to Professor Grey Turner for valuable help in this con-
nexion after he had watched me with some horror divide both inguinal
ligaments in the same patient in the space of twenty minutes.   The skin
incision in the groin is now closed and the patient put in the lithotomy
position.   Here I abandoned the scalpel for the diathermy as this con-
siderably reduces the hæmorrhage. I now make an incision down the inner
side of the top of the thigh as far back as the ischio-rectal fossa and deep
enough to expose the external obturator muscle.   The incision is carried
medially at its posterior end to the perineum, just above the anus. This is
repeated on the opposite side and the two incisions joined.   The vaginal
wall is divided above the hymen and the urethral orifice conserved
(Fig. 7). The upper part of the mons is already freed and removal of this
is completed during the course of which the periosteum of the symphysis
is exposed.   The vulva and its surrounding tissues and the associated
lymphatics are now freed. The bleeding is arrested and a catheter inserted
and the wound packed with tulle gras. There is no possibility of closing the
wound except in the perineal region and if there were I should be dis-
satisfied with the result and expect a local recurrence. If the growth is
near   the   urethra   then   I   remove   the   lower   three-quarters   of   that
structure and this is quite compatible with subsequent urinary continence.
If the anus is involved, I remove it and the anal canal and establish an
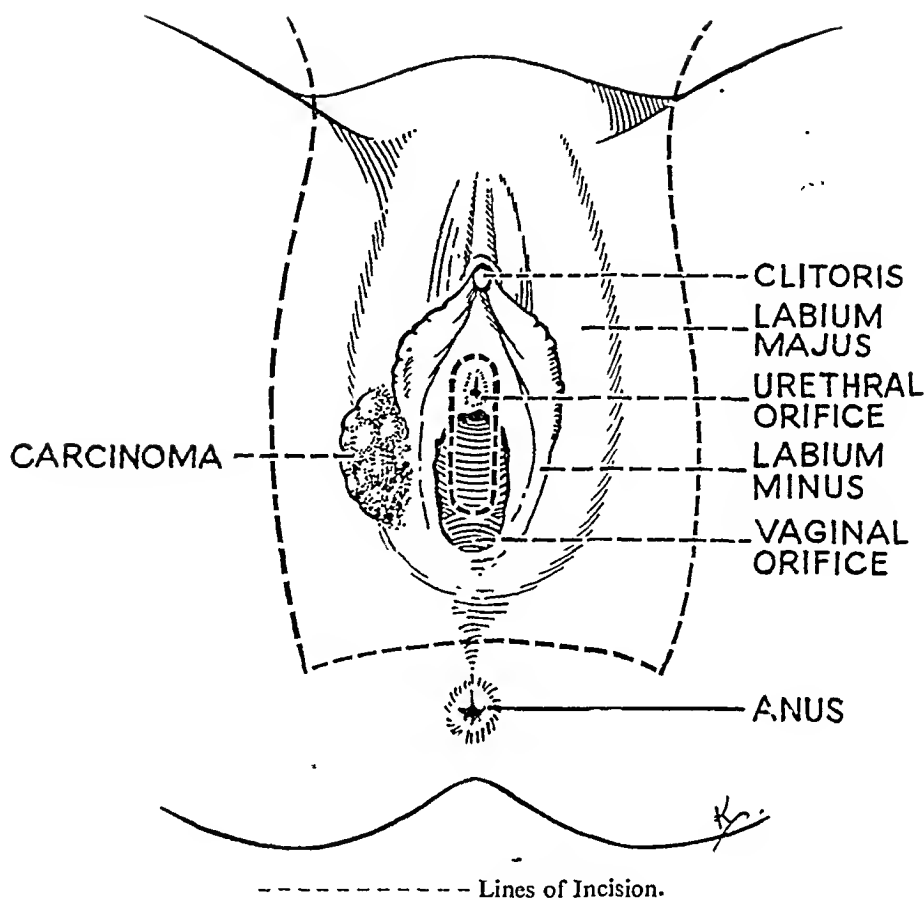inguinal colostomy when the groin wound has healed.

Fig. 7. Diagram illustrating the radical removal of the Vulva.

Complications

The complications are immediate and remote. The first of these is *fluid loss from the raw area*. Immediate post-operative hæmorrhage can be avoided by adequate diathermy coagulation but the loss of serum from so large an area is sometimes serious. The symptoms are characteristic. About twelve hours after operation the patient becomes restless and mentally confused and usually makes attempts to get out of bed. The tongue is dry and brown and thirst is intense. It is probably the thirst that causes them to get out of bed in search of fluid. The blood urea rises rapidly. The prevention of this is to maintain an adequate fluid balance by making the patient drink after operation, and if from clinical observation it is obvious that fluid loss is exceeding the intake, a plasma drip must be employed. I have lately used a solution of thrombin sprayed

over the wound to attempt to stop this. It forms an immediate and fine coagulum all over the raw area, but its introduction is too recent to allow any assessment of its value.

Wound Sepsis

This appears to be almost inevitable to some degree. It can be extremely serious. Half of my groin wounds heal by first intention and all my vulval wounds become infected to some degree. I am not alone in this complication. McKelvey of Minneapolis (1947) in a recent paper said that in his experience immediate grafting, penicillin and sulphonamide have made no difference, and with this I would agree. I have found that most neglected of all antiseptics, soap and water gives the best results and I have my patients immersed in a bath twice daily from the second day onwards. This seems to reduce infection to a minimum but does not abolish it altogether. I favour tulle gras (to give vaseline gauze its modern name) as a dressing and when the wound begins to granulate I employ alternate dressings of brilliant green and lotio rubra in the same manner as Sampson Handley dealt with his raw breast wounds. On three occasions where infection has spread through the periosteum over the symphysis, osteitis has resulted. In two cases it followed radical removal of the clitoris and in one deep X-ray therapy had been employed with subsequent necrosis and recurrence. With penicillin and drainage and the removal of dead bone it clears up quickly. Secondary hæmorrhage I have never seen despite the presence of sepsis. Venous thrombosis occurred only once and then in a patient whose femoral vein I had to ligature. I believe that early ambulation is of great value in the prevention of thrombosis and like most American workers I get my patients up on the second day. When the wounds are clean I employ Tiersch grafting to reduce the time of hospitalisation.

The remote complications that I have encountered are :

Lymphœdema. This almost always occurs and lasts for about 18 months. Only once have I seen it assume elephantine proportions. The removal of the inguinal skin flap seems to prevent its appearance in the groin wound as I have never seen it appear there.

Hernia. In my early cases I did not repair the femoral canal. Four out of twenty subsequently developed hernia.

Stenosis of the vagina. This occurs infrequently through gross cicatrisation round the vaginal orifice. In one patient the urethral orifice became obliterated and a subsequent plastic operation was necessary.

Prolapse. This is a more common complication than the last since the supports of the lower end of the vagina are removed and the introitus enlarged. It is quite possible to repair them by the ordinary plastic procedures.

It must not be supposed that all these complications are seen frequently. Apart from wound sepsis and fluid loss and lymphœdema the others are not frequently seen and the patients are surprisingly normal afterwards.

One of my patients aged 28 became pregnant for the first time two years after this operation and I delivered her by Cæsarean section just over a year ago. Another aged 29 contracted gonorrhœa 18 months after operation.

Results

Since 1942 I have performed the one-stage operation on 41 occasions and the two-stage operation on two occasions, a total of 43 operations. Two of these were incomplete on account of the presence of fixed iliac lymph nodes which could not be removed. There were seven fatal cases giving an operative mortality of 16 per cent.

Fatal Cases

Four patients died of heart failure from 12 hours to 36 hours following operation. Two of these were known to suffer from heart disease. Two died of wound sepsis, and one, a nun of 70, having successfully negotiated a two-stage operation, decided three weeks later that her life's work was finished, just faded away, refused to be interested in living and died of hypostatic pneumonia.

The majority of these deaths have occurred not in the first part of the series but in the latter part and were to a certain extent contributed to by my refusal to regard any case which did not have ulcerating fixed nodes as inoperable. I have learned several valuable lessons. In the very old or very feeble and in patients with known heart disease I now believe that it is right to sacrifice the advantages of a one-stage *en bloc* operation for a two-stage operation. Hitherto, on the few occasions I have performed a two-stage operation I have believed that the primary and vulva should be removed first on the theory that as some time must elapse between the first and second stages there is a risk, during that time of further lymphatic emboli in new channels. I believe that this argument may be purely theoretical for Taussig's cases were dealt with by a two-stage method in which the nodes were operated upon first and his results are admirable. The disadvantages of operating on the vulva first is that a huge raw area, which inevitably becomes infected to some degree, is left behind and it may be as long as six weeks before the nodes may be removed. If, however, the nodes are dissected first there is no raw area and these wounds heal very quickly. The mons and the vulva may then be removed and there should be less danger of the groin wounds breaking down on account of infection spreading from the vulval area and I propose in future to perform a series of cases on these lines.

Before considering the mortality further, I would like to present the results of the operations performed up to six months ago. There were 38 cases with five primary deaths. In 13 of these the nodes were involved and in 25 the nodes were not involved. In the 13 cases in which the nodes were involved there was one primary death, one has survived six years and four have survived more than three years ; four are alive and well

from six months to two years and one operated on two years ago is untraced as yet, but at all events up to six months ago her death had not been recorded by the Registrar General. Two of the patients are dead, one of them in whom there were fixed iliac nodes which had to be left, thus making the operation incomplete, died three months later and the other in whom there were involved external iliac nodes died nine months after operation with metastases in the spine and the head of the left humerus but without local or pelvic recurrence (Table 11).

TABLE 11

RESULTS OF TREATMENT

The Extended Radical Operation Nodes Involved

		Cases
Total	.. 13	
Primary deaths*	.. 1	(7·7 per cent.)
Alive and well six years	.. 1	
Alive and well four years	.. 4	
Alive and well three years	.. 2	
Alive and well six months to two years ..	.. 2	
Untraced†	.. 1	
Dead*	.. 2	

* Includes one incomplete operation.
† Subsequently traced. Alive and well, March 1948.

There were 25 cases in which the nodes were not involved. There were four primary deaths. Four will very shortly have survived five years and so far eight cases or 100 per cent. of those surviving operation and operated upon more than three years ago, are alive and well without recurrence. Thirteen are alive and well without recurrence six months to three years after operation and there have been no deaths (Table 12). Out of a total of 38 cases there were therefore five operative deaths, one is untraced, two have died of cancer and 30 are surviving from six months to six years (Table 13).

TABLE 12

RESULTS OF TREATMENT

The Extended Radical Operation Node Free Cases

		Cases
Total	.. 25	
Primary deaths	.. 4	(16 per cent.)
Alive and well four years	.. 4	
Alive and well three years	.. 4	
Alive and well two years	.. 4	
Alive and well one year	.. 7	
Alive and well six months	.. 2	
Dead	.. 0	

TABLE 13

RESULTS OF TREATMENT

The Extended Radical Operation
1942 *to June* 1947

	Cases	
Total	38	
Primary Deaths	5	(13 per cent.)
Dead of cancer	2	
Surviving six months to five years	30	
Untraced*	1	

*Subsequently traced. Alive and well, March 1948.

Sixteen cases have passed the three-year mark. Seven of these had nodal involvement and nine had not. There was one operative death in this group and there have been no recurrences or deaths in the remainder. In this group there is an operative mortality of 6 per cent. During this stage I rejected one case, giving an operability rate of 94 per cent. My absolute three-year survival rate is therefore 88 per cent. This is of course a very small series but Taussig's figure for a comparable number of cases over a comparable number of years is 73 per cent. I would like to hand on these figures as no more than an indication of what can be achieved by surgery alone on a planned rational basis in the treatment of this miserable disease, and to serve as a stimulus to improvements in technique and above all to attempts to really set out to obtain a worthwhile achievement in the treatment of vulval cancer. I have not been frightened by a high primary mortality or the criticism which this may bring. Any man who is frightened of a high primary mortality should abandon cancer surgery forever. If it were possible to obtain a figure of say 30 per cent. five-year cures in gastrectomy for carcinoma of the stomach then at the present moment an operative mortality of 50 per cent. would be totally justified.

Fortunately, carcinoma of the vulva is an uncommon disease and this operation and others like it call for team work and a high degree of theatre, ward and ancillary service organization. It is obviously not the operation for everyone to perform. There are just not enough cases to give all sufficient experience. I have been extremely fortunate in that my colleagues have freely handed me such cases as they have seen. This is the solution to such a problem, the concentration of all these cases in the hands of a few who have the willingness and temperament to deal with them. If they have the willingness and the temperament the ability will follow with practice. This, of course, means that a number of surgeons will have to forego treating these cases. Is this not a laudable sacrifice? What comfort can there be to one's professional pride in doing one possibly incomplete operation every 18 months with results as poor as those returned by most surgeons heretofore. The patient's interests would be

best served by sending these cases to teams who have the facilities, the willingness and the knowledge to deal with them in a radical manner.

One final point I should like to emphasize, some of my critics have informed me that I am wasting my time since carcinoma of the vulva is seen only in old women and their expectation of life is very short. In 278 cases admitted to the Royal Victoria Infirmary, Newcastle since 1908 the average age was 63 and 154 or 56 per cent. were below the age of 60. The oldest was 83 and the youngest 17. If, when my critics reach the age of 60 they should then be stricken with some fell disease for which they refuse to seek relief, I will admire their constancy but I will not listen to their counsel.

This may indeed appear a fearsome operation for a disease which in many cases could be so easily prevented, but for the treatment of established cancer I will leave the comparison of the results of those who have practised the wide excision with those who perform less extensive procedures to speak for itself. In the vulva we have before us the pre-malignant and the malignant lesion side by side, and here may be the key to the riddle of cancer. These cases must be concentrated into the hands of teams who can not only deal with them on a planned rational basis but use this unique material for providing the knowledge which we hope will make this operation and others like it a memory of the past.

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INTERNAL DERANGEMENTS OF THE KNEE JOINT

Lecture delivered at the Royal College of Surgeons of England

on

15th July, 1948

by

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THE KNEE WHICH IS the largest and the most important, is also the most unstable of all the joints concerned in weight-bearing. Relying entirely for its stability on the complicated series of ligaments which extend through and round its substance, it is supported on all sides by the musculature of the thigh and calf. Any strain on the knee joint is borne in the first instance by these supporting muscles, and only when the musculature is under-developed or the strain is excessive, does injury to the ligaments and to the joint lining become inevitable.

The Ligaments of the Knee

The crucial ligaments extending through the joint at right angles to each other, hold the femur in its normal relation to the upper surface of the tibia. Without their support antero-posterior gliding of the femur on the tibia would render the knee joint unstable, and even a laxity of either ligament causes a feeling of great insecurity.

The anterior crucial ligament, firmly attached to the upper surface of the tibia at the side and base of the anterior tibial spine and to the posterior portion of the intercondylar surface of the external condyle of the femur, is frequently stretched or torn by forced hyperextension of the knee. Directly after the occurrence of the injury it may be extremely difficult to diagnose the exact type of injury which has occurred.

The joint is swollen with hæmorrhage and synovial effusion, consequently all movements in the joint are resisted, and the tibia and the femur remain more or less in their normal alignment and the radiographic examination is therefore of little assistance in diagnosis. When the fluid has disappeared, either as a result of aspiration or absorption, the exact type of injury can be appreciated by the discovery of the abnormal mobility of the tibia on the lower end of the femur. This can easily be demonstrated when the muscles are released either with the knee at right angles or in the fully extended position when the upper articular surface of the tibia can be pulled forward to lie as a prominent bony shelf in front of the articular surface of the femur. When the pressure of the examining fingers is removed from the tibia, the bones again take their normal relationship sometimes with a definite feeling of grating as the cartilages slip back with the tibia into their normal position. The type of treatment which should be given for the injury depends on the length of time which

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has elapsed between the injury and the recognition of the disability. When the injury is recent, treatment should always be essentially conservative.

Conservative Treatment

The outstanding justification for conservative treatment rests on the fact that although it may appear by clinical examination that the crucial ligament has been completely ruptured, the injury is, as a rule, at first only partial. Part of the ligament remains attached to both femur and tibia, the fibres which are left are stretched and weak but are still continuous and by prolonged rest in a position of relaxation, satisfactory healing of the ligament can often be obtained. After aspiration of the fluid contents of the joint the whole limb should be immediately immobilized in a position of 15-20 degrees flexion and maintained in that position for a period of 3-4 months. This period may appear to be unduly long but the disability which follows an unhealed tear of the ligament is so severe and the results obtained by operative treatment are so unsatisfactory that the long period of immobilization is highly justified.

The immobilization and rest of the limb is most readily effected by applying a long plaster case from the lower calf to the upper thigh, sufficiently long to control all the movements of the joint. During the period of immobilization the muscles of the thigh waste from disuse and from the effects of the controlling case and it is advisable at the end of the first month to remove the anterior portion of the plaster shell and prevent further wasting by massage and by voluntary muscular exercises which should not produce movement in the joint.

If as a result of fixation the injured ligament is healed, the inevitable muscular wasting which is caused by the prolonged fixation can be rapidly overcome by physiotherapy and exercises.

Operative Treatment

The suture of a torn crucial ligament by opening the joint and joining the two separated portions by catgut, silk or silver wire attracted surgeons for many years. Unfortunately, the results of these procedures were always unsatisfactory. It was a comparatively simple matter to open the joint and join the divided ends, but the catgut which was used for suture was rapidly absorbed by the joint fluids and if silk or silver wire were employed they acted as foreign bodies and caused a rapidly increasing arthritis of the joint.

The best of the operative methods was that of Hey Groves in which after making a bore hole through the tibia and femur with inner openings at the site of the attachment of the injured ligament, a twisted cord of fascia lata, still attached at its lower end, was threaded through the two bones and anchored in position by sutures. This procedure seemed at first to be the answer to the problem, but gradually the new ligament became elongated, the instability of the joint reappeared, and the knee again became unreliable.

Because of the invariable failure of all types of operative treatment, conservative measures should always be employed. If, in spite of adequate treatment, the ligamentous stability of the joint is not restored, every effort should be made to replace the function of the crucial ligaments by increasing the power of the muscular control of the joint by massage and exercises. The improvement which can be obtained by increased development of the muscles of the thigh and calf is remarkable. Even with a divided anterior crucial ligament, control of the limb can to a large extent be regained and walking and even mild games can be indulged in with confidence.

Injuries of the posterior crucial ligament are seen rarely, and then usually following severe motor or train accidents in which the tibia has been forced backwards on the femur whilst the joint was at right angles.

The clinical signs of this injury are very similar to those caused by rupture of the anterior crucial ligament. The knee is unstable, walking is possible, but any active pursuits are prevented by the sliding of the femur on the tibia. The injury is not usually recognized in its early stages, the great swelling of the joint producing tension and comparative stability masks the essential clinical features and only when the fluid has been removed or absorbed can the exact injury be diagnosed.

For the same reasons as are applicable in injuries of the anterior crucial ligament, conservative measures of rest and immobilization should be undertaken immediately. As a rule the posterior crucial ligament is not completely torn, some strands of the ligament are left continuous and with adequate rest stability can usually be obtained.

Instability of Both Crucial Ligaments.—Occasionally both crucial ligaments may be torn at the same time. The mechanics of such an injury are difficult to understand ; probably there is first a hyperextension of the joint and then the tibia is forced backwards. When the knee can be examined, the antero-posterior mobility of the femur on the tibia is found to be extreme, the tibia may be brought forward or backward on the femur to an excessive degree and the knee is quite unstable even if good muscular development is present.

Although complete division of these ligaments can only follow on a severe injury, instability of the joint due to laxity of the ligaments is often the result of a long continued synovial effusion. Under these circumstances the patient complains of wobbling of the joint, and on examination considerable antero-posterior movement of the tibia on the femur is possible although not to the extent which occurs following rupture of the ligaments.

The treatment of a knee joint in which both crucial ligaments have been torn should be carried out on the same lines as those adopted for a similar injury to a single ligament—rest and immobilization of the joint at an angle of 20-30 degrees for a period of 3-4 months is essential, and the same routine of physiotherapy in the split case should be used in the second half of this period of rest.

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The prospects of recovery following this line of treatment depend on the severity of the ligamentous injury. If this is complete, instability will remain in spite of the most prolonged-immobilization, but with the usual partial tears, recovery is the rule. When the tears are complete and no stability has followed on the conservative treatment, operative measures to suture the ruptured ligaments are always unsuccessful. Stability of the joint can be improved by the use of a hinged knee-cage which embraces the femur and the tibia and allows only antero-posterior movements. This method of strengthening the joint may be satisfactory for years, but if both crucial ligaments have been torn, and especially if the original injury has been very severe, osteoarthritis of the joint eventually develops and causes so much pain that arthrodesis may be required.

Lateral Ligaments

The internal lateral ligament acts in association with the anterior crucial ligament; both become tense on full extension of the joint and where one ligament has been injured the other is usually involved if the causative force has been sufficiently severe. Injuries to the internal lateral ligament may be complete or incomplete.

Incomplete Injury or Strain of the Internal Lateral Ligament.—The result of forced abduction of the leg while the joint is in a position of full extension is characterized by the presence of pain and tenderness over the injured ligament, as a rule at its femoral attachment, while forced abduction of the leg at the extended knee increases the complaint. There is, as a rule, little or no abnormal movement in the knee and following rest the tenderness and pain rapidly disappear.

Rupture of the Internal Lateral Ligament.—A complete rupture of the ligament is a comparatively uncommon accident; when it does occur it is often associated with rupture of the anterior crucial ligament. The knee is very unstable, weight-bearing without protection being almost impossible, whilst the leg can be abducted at the extended knee to an angle of 25-30 degrees.

The primary treatment of this injury should always be conservative; fixation of the joint at rest in slight flexion for a period of 2-3 months usually results in healing of the torn lateral ligament, and at least in improvement of the injured crucial ligament.

Operative Treatment of Ruptured Internal Lateral Ligament.—When conservative methods have failed or when the interval of time between the injury and the onset of treatment is so great that healing of the ruptured ligament would be improbable, operative treatment is advisable if the patient's disability is severe.

The object of the operation is the suture of the ruptured ligament and its reinforcement by the tendon of the semitendinosus muscle. The inner side of the joint is approached through a 6-inch incision extending downwards behind the adductor tubercle of the femur. The torn internal lateral ligament is defined whilst the tendon of the semitendinosus muscle

is brought forward from its position behind the knee joint by dividing its retaining fascia. The tendon, still firm at its attachment to the tibia, is laid along the course of the internal lateral ligament. A deep groove is now cut vertically in the adductor tubercle and the displaced tendon placed in this groove into which it is fixed by deep sutures. A similar opening is made on the inner aspect of the tibia near the articular surface, and into this the lower portion of the tendon is firmly sutured while suture of the torn ligament to the transposed tendon completes the operation. The after-treatment is rest of the limb for a period of three weeks without weight-bearing, followed by exercises of the joint and supported weight-bearing for the following 4-6 weeks.

External Lateral Ligament.—Because the normal inclination of the knee is towards the middle line of the body, injuries of the external lateral ligament occur less frequently than similar injuries on the inner side of the joint.

Following injury of the external lateral ligament, tenderness is usually present over the fibular attachment of the ligament while abnormal adduction of the leg at the extended knee joint is possible to a varying extent. The injury causes much less disability than that following injury of the internal lateral ligament ; the strain on the outer side of the joint is not great on account of the line of the femur and tibia, while the outer side of the joint is protected by the strong ilio-tibial band of fascia lata and by the powerful biceps femoris.

As a rule improvement follows rest and immobilization, but even with a permanently unhealed tear of the ligament, ordinary activities can be indulged in and operative interference is never indicated.

The Semilunar Cartilages

The Internal Semilunar Cartilage.—Because of the normal inclination of the thigh and leg, injuries of the internal cartilage occur much more frequently than those of the external. The occurrence of injuries of the internal cartilage is also predisposed to by the attachment of the deep fibres of the internal lateral ligament to its convex outer surface. Because of this attachment the cartilage is more firmly anchored to its position on the upper surface of the tibia than the more mobile external cartilage which, by its mobility, does not suffer the frequent strains and tears to which the internal cartilage is subjected.

The classical method of injury to the internal cartilage is by a forced rotation inwards of the femur on the fixed tibia and if this clinical history can be elicited it is of some help in making a diagnosis. Frequently the injury has occurred so rapidly that the patient has no clear idea as to the exact mechanics of the injury and it is always unwise for the surgeon to suggest to the patient the possible mechanics of the injury unless this information is volunteered by the patient.

Certain facts about the injury are definitely proved ; a lesion of the cartilage cannot occur unless the joint is in a position of flexion. When

the joint is fully extended and great force is applied on its outer side the internal lateral ligament may be ruptured, but even with great force in this position cartilage injuries do not occur, as the rupture of the ligament occurs above its attachment to the cartilage.

On its first occurrence, an injury to the internal cartilage may not be followed by a " locking " of the joint and this so-called " locking " may only occur after repeated traumata. The explanation would appear to be that the first injury to the cartilage may start a tear in its substance, and with repeated injuries the tear may extend enabling the displaced portion to project further between the femur and tibia. As a rule, each so-called " locking " of the knee is followed by synovitis, at first large in amount, but diminishing with each subsequent accident until after repeated injuries it may be difficult to recognize that fluid is present in the joint. With· each " locking " there is a considerable amount of pain usually along the inner aspect of the joint, but when replacement has been effected the pain rapidly disappears. Accompanying the pain and lasting for a much longer period, tenderness on digital pressure can be elicited along the inner margin of the articular surface of the tibia. This tenderness may be greater over the anterior or over the posterior portion of the joint, but careful examination will elicit the fact that it is always present over the middle of the internal lateral ligament. This point of tenderness over the attachment of the deep fibres of the internal lateral ligament to the · cartilage is an outstanding sign of injury to the underlying meniscus and is of more importance than tenderness in any other portion of the joint. Accessory methods of examination for the diagnosis of cartilage lesions are of very great importance. The two most commonly used methods are air arthrography and manipulative examination.

Of these two methods, examination by manipulation although difficult can give more definite information about the exact conditions of the suspected cartilage. The basis of the test depends on the fact that at least 75 per cent. of cartilage injuries occur in the posterior half of the joint, and when a tear of the cartilage can be seen from the anterior portion of the joint it is almost invariably an extension of an injury which began posteriorly.

In using the method, the patient lies flat with all the muscles relaxed. The surgeon grasps the foot on the affected side using the power of the forearm to produce the rotation of the limb. The knee and hip are now fully flexed until the heel approaches or touches the buttock and, holding the leg in a position of external rotation, the knee and hip are brought down to the extended position. The knee is again fully flexed and then slowly straightened with the leg in a position of full internal rotation. During these movements any abnormality of the semilunar cartilage can be defined not only in regard to its presence but also the site and extent of the lesion can be judged from the occurrence of a distinct painful click constantly occurring at the same point of extension. In this test the

abnormal click which is painful can be distinguished from the painless sound produced by movement of a loosely attached uninjured cartilage.

Treatment of a Lesion of the Internal Cartilage.—It is wise to treat the first injury of an internal cartilage by rest and immobilization of the joint in the hope that the tear in the cartilage may heal and so avoid the necessity for operative interference.

As a rule, even after prolonged immobilization of the joint, recurrence of the disability is inevitable and operation must be undertaken. Healing of a torn cartilage may however occur if the tear is present on its outer rim. At this point there is a good blood supply from the perisynovial tissues and healing occurs as in any other situation by the formation of fibrous tissue. If, however, the tear is in the usual situation in the substance of the cartilage, healing can never take place and further tearing of the cartilage is inevitable.

Differential Diagnosis

(1) *Adhesions.*—Following a direct blow or strain of the knee, the normal mobility of the tissues is lost owing to the formation of fibrous tissue in the injured area. When the strain has occurred on the inner side of the joint and scar tissue has formed in the synovial or perisynovial tissues, acute stabbing pain and pseudo " locking " are to be expected when this area is stretched by some particular joint movement. This stabbing pain simulates very closely the locking of an injured cartilage. The knee feels useless and is usually held flexed and the differential diagnosis may be for the moment in doubt ; but this apparent " locking " which occurs suddenly is never followed by a sudden " unlocking " and is never followed by the development of synovitis in the joint. The joint slowly straightens and with physiotherapy and free use, movements are increased and improved.

(2) *Osteoarthritis.*—Pain and a feeling of nipping at the front and inner side of the joint are characteristic symptoms in osteoarthritis of the knee. Following the attack of pain the normal function of the joint is slowly restored and the radiographic picture shows the characteristic lipping of the articular margins.

(3) *Loose Bodies.*—These may give rise to a typical " locking " and " unlocking " on many occasions, but the site of locking is never constant, varying from the inner to the outer side. It is frequently possible to palpate the body in the joint and when bony tissue is present in the loose body, it can be demonstrated by radiological examination.

(4) *Diagnosis of wrong Cartilage Lesion.*—As a rule the signs and symptoms of an internal cartilage lesion are comparatively definite, but mistakes may easily be made in the diagnosis and without careful manual examination of a knee it is often impossible to distinguish between a lesion of the inner or outer cartilage.

(5) *Slipping Tendon.*—Occasionally the semitendinosus tendon slips round the inner side of the knee with a definite snap which may be

accompanied by considerable pain or discomfort, and on occasion the biceps tendon inserted into the fibula rather lower than usual can be seen to slip forward and backward over its upper border. The diagnosis is easy if the whole joint is enclosed in the hands when the examination is being made.

(6) *Ruptured Crucial Ligament.*—A curled up torn anterior crucial ligament may be caught between the femur and the tibia and may cause symptoms and signs very similar to those of a torn cartilage. Examination of the knee with this possibility in mind clears up the diagnosis.

(7) *Slipping Patella.*—The sudden slipping of the patella to the outer side of the femur causes great pain and is immediately followed by an inability to extend the joint. The power of straightening is suddenly restored when the leg is pulled straight and the mistaken diagnosis of an internal derangement may easily be made. The abnormal lateral mobility of the patella when the knee is extended is a clear indication of the cause of the disability, even though the patient was not seen at the time of the accident.

Treatment of a torn or displaced Internal Cartilage.—When a semilunar cartilage is torn or displaced and the joint is otherwise healthy, removal of the cartilage is necessary and is the only method of restoring full normal function. Manipulation has no place in the treatment of these injuries, apparent success by the method always being due to an error in the original diagnosis.

In the removal of the injured cartilage, there are certain essential points in technique.

(i) The incision should only be of sufficient length for the removal of the injured cartilage ; a large incision does not increase the view at the site of operation and no exploratory operation is ever justifiable and although these large incisions would appear to give a better view of the operation field, they are invariably followed by creaking in the joint and the patient, as a rule, cannot carry on with athletic pursuits.

(ii) *The whole cartilage should always be removed.*—In the ordinary type of bucket-handle injury it is a great temptation to remove only the displaced portion, but the rim left *in situ* continues to cause symptoms in those who indulge in vigorous games.

(iii) *Injury of the Synovial Lining.*—No clamp or forceps should be applied to any tissue which is being left *in situ* in the joint. Smooth, flat retractors should be used and only the cartilage itself should be held in a clamp.

(iv) *A Tourniquet should always be used.*—Unless the operation is conducted in a bloodless field, the view of the joint is distorted and spoiled and it is therefore advisable that in every instance an efficient tourniquet should be maintained on the limb until the wound has been sutured and the dressings have been firmly applied.

If the synovial lining and perisynovial tissue have been carefully sutured, bleeding into the joint can be avoided by the application of a large mass of sterile gauze and wool firmly bandaged over the knee before the removal of the tourniquet.

(v) *Rest of the Joint Following the Operation.*—If the surgeon is sure of his technique, the joint should be rested on a splint for a week or 10 days following the operation. Following this routine reactionary swelling is avoided, the wound heals more firmly and the period of convalescence is definitely shortened.

The External Cartilage

The symptoms and signs produced by lesions of the external cartilage are very similar to those following injuries to the inner meniscus. Locking of the joint is not such a feature of the clinical history and the site of tenderness is as a rule on the outer side of the joint.

Congenital maldevelopment of the external cartilage may also give rise to a chain of symptoms and signs which are never seen in connection with the inner cartilage.

In this condition the external cartilage is represented by a complete plate in which the normal central absorption of the cartilage has not taken place. This plate is not of equal thickness over the whole of its extent, being thin in the central portion and having a thicker portion behind and in front of this depression.

The presence of this congenital abnormality can be recognized in patients of any age. Flexion of the joint is completed normally but on active full extension a distinct and loud snap is produced by the sliding of the condyle of the femur over the posterior thickening of the cartilage. The condition may not cause any great inconvenience but if pain of synovitis is produced by the movements, removal of the cartilage is essential.

Cysts of the Semilunar Cartilage

Cystic degeneration of portion of a cartilage may occur in connection with either cartilage, although the change is found usually on the outer side of the joint. The cyst appears at examination as a smooth, tense structure, projecting outward, either in front of, or behind one of the lateral ligaments. The complaint of the patient is almost invariably of a constant aching pain in the joint, not very severe but increasing with use. The cyst is more apparent when the knee is fully extended, and the tension in the cyst may be so great that a diagnosis of osteoma may be made if no radiograph is available. Some difficulty in diagnosis may arise between cyst of the cartilage and an enlarged bursa near the insertion of the biceps tendon ; the appearances are very similar, but the complaint of persistent aching, made worse by activity, and the increase in size of the tumour, which occurs when the limb is extended, are sufficient to distinguish the two conditions.

Treatment of Cysts of the Cartilage.—Aspiration of the fluid content of the cyst, or local removal has always led to recurrence, and to a continuation of the symptoms. The only satisfactory treatment is removal of the whole of the cartilage from which the cyst is derived.

The operation of removal should be carried out with exactly the same technique as that for removal of the injured cartilage. Some surgeons believe that removal of the cartilage with the whole cyst and cyst wall is a necessity ; in my experience, cutting through the cyst and leaving a portion *in situ* leaves a better knee joint and does not cause the long period of incapacity and convalescence which follows the more extensive operation. When completed in the manner suggested the synovial membrane is not so widely removed. Closure of the wound is possible with approximation of the cut synovial margins, and the period of disability is very slightly longer than that after removal of a broken cartilage.

After Treatment.

In no branch of surgery is there so much variation in the type of treatment used following the operation. It is claimed that early active movements of the joint prevent stiffness, maintain the muscle group to almost their normal strength and allow earlier activity. In my experience, after the unavoidable trauma of the operation, the joint requires, above everything else, rest in order to prevent synovial effusion and even hæmarthrosis. If the operation technique is gentle, if no forceps have been applied to the synovial lining, and if the line of sutures in the synovia is satisfactory, no stiffness of the joint is to be expected.

SAYINGS OF THE GREAT

" There are extremists who try to divert what began as a great spiritual and social crusade into a sordid materialistic and class dictatorship."— *Trotter.*

" It is not a profession, it is not a nation, it is humanity itself which, with uncovered head, salutes you."—*Ambassador Bayard, addressing Lister at The Royal Society Banquet.*

" Put your affections in cold storage for a few years, and you will take them out ripened, perhaps a little mellow, but certainly less subject to those frequent changes which perplex so many young men."—*Osler.*

" Defer not charities till death ; for certainly if a man weigh it rightly, he that doth so is rather liberal of another man's than of his own."—*Bacon.*

Note.—Contributions are invited.
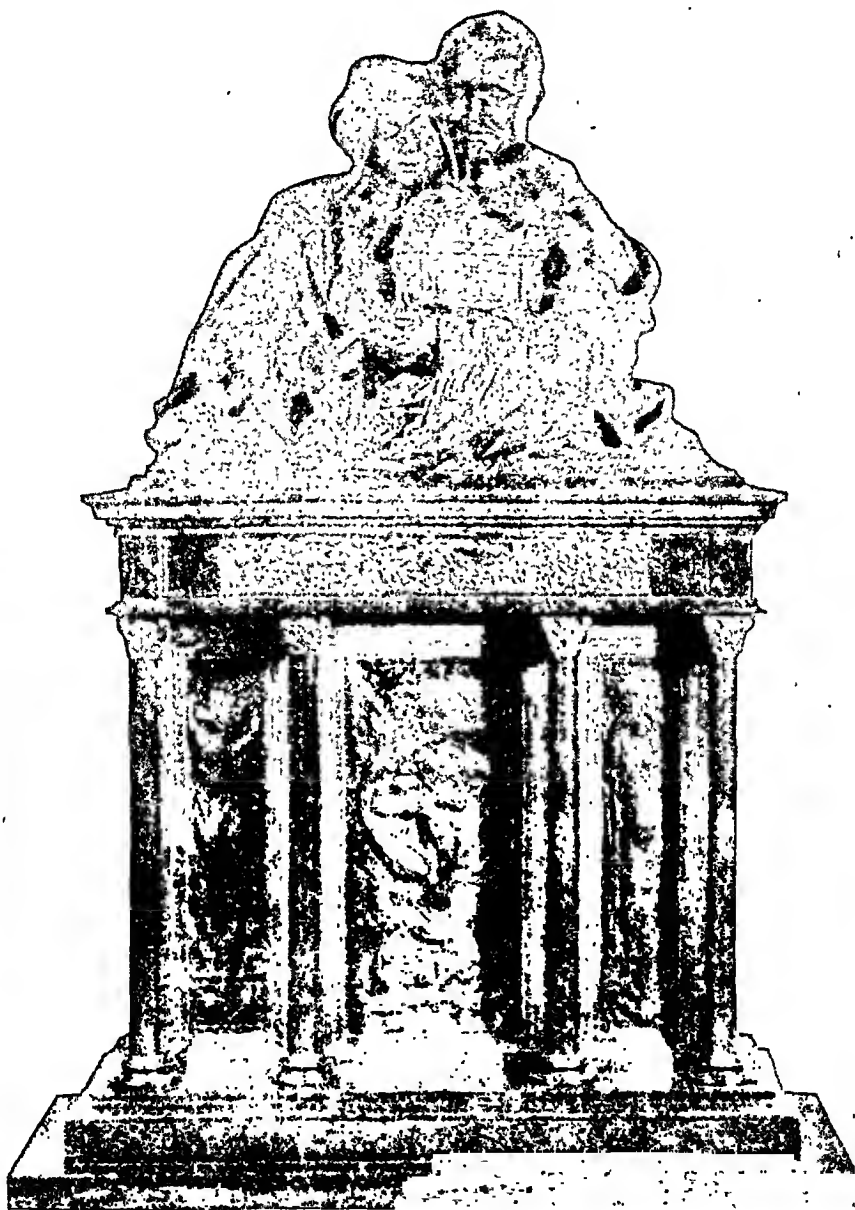
"MORS JANUA VITÆ"

" OBSERVABLES " AT THE ROYAL COLLEGE OF SURGEONS

10. " MORS JANUA VITÆ "

IN THE LAST NUMBER of the *Annals* there is a description of Gilbert's Bust of Richard Owen, but this is not the only work by Alfred Gilbert in the possession of the College. In the north-east corner of the Main Hall there is a remarkable piece of sculpture in marble and bronze which includes a Cinerary Urn for the Ashes of Dr. and Mrs. Macloghlin. It is a grave ; but it is also a precious Work of Art. It was placed in the College at the urgent request of Mrs. Macloghlin, widow of Edward Percy Plantagenet Macloghlin, a distinguished student of University College, Liverpool, and a Member of the College. For some years he was in practice at Wigan. There is a plaster model of " Mors Janua Vitæ " in the City of Liverpool Walker Art Gallery.

Even in prehistoric times there is evidence of man's concern about the fate of his mortal remains, and all through recorded history there are accounts of exact instructions being given for their disposal. The practice of making elaborate provision for interment probably reached its fullest development in ancient Egypt, where the Kings and others provided the most remarkable tombs for themselves and their relatives and trusted servants. The beliefs of the Egyptians with regard to death were hope-lessly confused, like those of most other peoples. They loathed the idea of death and did their best to persuade themselves that the dead were not actually dead at all. Their whole conception of the tomb seems to have been based on the passionate desire to deny the very existence of death.

And so, linked with concern about the disposal of mortal remains is a belief in human immortality, which in some form or other is almost universal. Even in early animistic cults the germ of the idea is present and in all the higher religions it is an important feature. There is evidence that these ideas influenced the Macloghlin Memorial ; firstly in Mrs. Macloghlin's anxiety with regard to the disposal of her remains and those of her husband, and her insistence on them being worthily enshrined in the College of Surgeons, which they both loved and admired ; and secondly in Gilbert's Work of Art in which the idea of human immortality is the essential feature. It is inherent in the design, and finds expression in the title which Gilbert chose for his work—" Mors Janua Vitæ "—Death is the gate of life.

Similar ideas were evidently in the mind of Sir John Bland-Sutton, as shown by the exact instructions which he gave for the disposal of his Ashes. He selected for his Cinerary Urn a covered bronze vase of Chinese workmanship which was among his most treasured possessions and he left instructions for this vase containing his Ashes to be built into the wall of the

Museum of the Bland-Sutton Institute at The Middlesex Hospital. There it rests to-day in a glass-fronted recess, and underneath for an inscription is a quotation of Bland-Sutton's request for such interment : " Let my Ashes find a place in the Museum of The Middlesex Hospital where I spent so many hours teaching students over the dead with the hope of aiding the living."

It is difficult to reconcile Bland-Sutton's concern about the disposal of his Ashes with the last words of his Hunterian Oration when he said : " If I could believe the soul of man survives the dissolution of his body, I would believe the spirit of John Hunter haunts the galleries of this wonderful Museum, but I do believe his influence is a quickening spirit among surgeons to-day."

One is driven to wonder whether Carlyle's words are not applicable to this confusion of ideas : " Men's words are a poor exponent of their thought ; nay, their thought itself is a poor exponent of the inward unnamed Mystery, wherefrom both thought and action have their birth."

Besides wishing the remains of her husband and herself to rest in the Royal College of Surgeons, Mrs. Macloghlin made large gifts to the College. She gave a beautiful Piastraccia marble floor for the Entrance Hall and Main Hall of the College. This she installed at a cost of £650 and requested that in the corner to the right of " Mors Janua Vitæ " might be engraved " in letters as small as possible "—" This marble floor to the Royal College of Surgeons from Eliza Macloghlin, 1911."

Mrs. Macloghlin died in 1928, and by her Will left to the College a sum of £10,000 and the residue of her estate, for the purpose of founding and endowing Scholarships for Medical Students in memory of her husband. The bequest was made in accordance with the intention and expressed desire of her husband who died in 1904.

In his early career Dr. Macloghlin was hampered by want of means, and it was only by his own labours and exertions that funds were provided for his education. It was the recollection of these early difficulties which, when success came in later life, suggested to Dr. Macloghlin the idea of founding Scholarships at the Royal College of Surgeons for the purpose of assisting young students in need of financial help.

To be eligible for an award candidates must be between the ages of $17\frac{1}{2}$ and 23, and must be men studying and seeking to qualify themselves as Members of the Royal College of Surgeons of England, whose conduct has been satisfactory and who are in need of financial assistance in the prosecution of their studies.

W-J.

THE LETTERS OF MEDICAL MEN

THOMAS BARTHOLIN the anatomist looked from Copenhagen three hundred years ago across a war-stricken continent, Germany devastated by thirty years of fighting, France and England each torn by civil war. As a young man he travelled through the medical schools of Europe, experimenting at Leyden and lecturing at Montpellier. After going home to Denmark he kept in touch with the scientific work going forward in many countries by means of personal correspondence. Private letters were the chief means of spreading knowledge of new work, for the use of printed periodical publications was only just beginning. Bartholin published a selection from his letter-books in 1663, and it was not till ten years later that he began to issue his *Acta medica et philosophica Hafniensia*; a collection of four hundred letters to and from Bartholin was published in 1740. These letters preserve a first-hand record of the currents of medical thought from that period of great intellectual activity and advance. Through them we can follow, for instance, the fortunes of Harvey's fame on the continent, and wonder at the slowness with which the discovery of the circulation was accepted.

How different was the welcome accorded to the discovery of vaccination. Jenner's name was quickly venerated throughout Europe, and indeed all over the world, as the saviour of humanity from its direst scourge. His correspondence became so vast that he could barely afford to pay the postage, charged in those days to the receiver or the customs dues on the books sent to him from abroad. His friend and biographer, Dr. John Baron, who quotes from several hundred letters written during the last twenty-five years of Jenner's life, could only find twenty letters from his first fifty years. Letters of obscure men are seldom preserved. We know that John Hunter kept all the letters Jenner wrote to him, from the time when he returned to Gloucestershire after he had qualified till Hunter's death twenty years later. But they had all been destroyed before Baron could see them, perhaps by Everard Home when he burnt Hunter's manuscripts in the year of Jenner's death.

Fortunately Jenner kept all the letters he received from Hunter, and most of them are now in the College Library, to which they were presented by Sir James Paget, President in 1875, who had bought them from Jenner's family. Among these original autographs is the famous letter of August 2nd 1775, often quoted but worth reading in full. Hunter was at work on the variations in the heat of animals. He had been experimenting with dormice, testing their reaction to freezing, and their heat when "torpid" or hibernating. He could not easily get hedgehogs at Kensington, and set Jenner to make similar experiments in Gloucestershire. Jenner had recorded the temperature of hibernating hedgehogs and was now

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at work on their summer heat. Hunter subsequently included Jenner's report in the paper which he read to the Royal Society. He had lately asked Jenner to join him in starting a school of comparative anatomy in London, and at the beginning of this letter he refers to Jenner's refusal to leave his country practice at Berkeley.

JOHN HUNTER TO EDWARD JENNER

Addressed : Mr. Jenner, Surgeon at Barkley, Gloucestershire.

Dear Jenner

I rec'd yours in answer to mine, which I should have answer'd. I own I suspected it would not do ; yet as I did intend such a scheme, I was inclinable to give you the offer. I thank you for your Expt. on the Hedge Hog ; but why do you ask me a question, by the way of solving it. I think your solution is just ; but why think, why not trie the Expt. Repeat all the Expt. upon a Hedge Hog as soon as you receive this, and they will give you the solution. Trie the Heat, cut off a Leg at the same place, cut off the Head, and expose the Heart and let me know the result of the whole

I am Dear Jenner
Ever yours
JOHN HUNTER

-Augt. 2d.

Of about one hundred letters, which are all that are now known from the thousands which Hunter wrote, sixty-nine are in the library among the most treasured of the College's possessions. Jenner's letters are much less forthright than Hunter's ; he suffered from a long-winded playfulness and a fondness for fanciful turns of phrase. His autographs none the less are very interesting and attractive documents, written on folded quarto sheets, as was still the custom, in a hand of pleasant elegance, less bold than Hunter's. Dr. H. B. Jacobs of Baltimore, who collected sedulously anything connected with Jenner, amassed 103 of Jenner's letters, though they are, as was said long ago, worth their weight in gold. The College is proud to possess no less than thirty-four, mostly personal letters to John Baron.

Second only to these in interest is the large collection of autographs formed by the Hunter and Baillie families through more than a century. Five large volumes of letters were presented to the College by William Hunter-Baillie, great-nephew of John Hunter, and five more by his daughter. They include the letter-books of John Arbuthnot, physician to Queen Anne and intimate friend of Swift and Pope, of William Hunter who knew everyone of importance or interest in the third quarter of the eighteenth century, and of Matthew Baillie the leading London physician of the following generation.

DIARY FOR OCTOBER

(15th—29th)

Fri. 15		D.M.R.D. (Part I), D.M.R.T. (Part I), and D. Phys. Med. (Part II) Examinations begin.
	10.00	Dr. S. Rowbotham—The Relation of Endocrine Imbalance to Anæsthesia.
	11.15	Dr. E. A. Pask—Circulatory Depression.
	5.00	Dr. E. A. Pask—Respiratory Depression.
	5.00	Mr. T. Holmes Sellors—Surgery of Pulmonary Tuberculosis.
Mon. 18	10.00	Dr. R. P. Harboard—Shock.
	11.15	Dr. G. Organe—Cardiac Arrest.
	5.00	Dr. B. Johnson—Analepsis and Resuscitation.
	5.00	Dr. D. W. Smithers—High Voltage X-rays in the Treatment of Malignant Tumours at a Depth.
Tues. 19	10.00	Dr. H. L. Marriott—Saline, Plasma and Blood.
	11.15	Dr. H. L. Marriott—Saline, Plasma and Blood.
	5.00	Dr. R. Woolmer—Convulsions.
Wed. 20	10.00	Dr. W. D. Wylie—Pulmonary Complication, Prevention and Treatment.
	11.15	Dr. H. G. Epstein—Physics in Anæsthesia.
	5.00	Dr. J. Challis—Ether Anæsthesia.
	5.00	Prof. J. Paterson Ross—Surgery of the Sympathetic Nervous System.
Thur. 21		Final F.D.S. Examination begins.
	10.00	Dr. W. S. McConnell—Nitrous Oxide-Oxygen and Dental Anæsthesia.
	11.15	Dr. W. W. Mushin—The Absorption Technique.
	5.00	Dr. J. Challis—Cyclopropane, Chloroform and Trilene Anæsthesia.
	5.00	Mr. P. H. Mitchiner—Surgery of Sepsis.
Fri. 22		D.M.R.D. (Part II), and D.M.R.T. (Part II), Examinations begin.
	10.00	Mr. I. W. Magill—Intubation.
	11.15	Dr. B. Johnson—Intravenous Anæsthesia.
	5.00	Dr. B. Johnson—Intravenous Anæsthesia.
Mon. 25	10.00	Dr. T. Cecil Gray—Curare and Like Substances.
	11.15	Dr. T. Cecil Gray—Curare and Like Substances.
	3.45	Mr A. M. A. Moore—Applied Anatomy of the Foot and Hand.
	5.00	Dr. H. A. Magnus—The Gastro-Intestinal Tract and Macrocytic Anæmia.
	5.00	Dr. A. Parry Brown—Anæsthesia for Thoracic Surgery.
Tues. 26	10.00	Dr. A. Parry Brown—Anæsthesia for Thoracic Surgery.
	11.15	Dr. E. H. Rink—Anæsthesia for Cardiac Surgery.
	3.45	Prof. D. T. Harris—Respiration.
	5.00	Dr. C. H. Andrewes—Recent Work on Viruses, their Nature and Habits.
	5.00	Dr. G. Organe—Abdominal Relaxation.
Wed. 27	3.45	Prof. D. T. Harris—Respiration.
	5.00	Dr. C. H. Andrewes—Recent Work on Some Virus Diseases.
Thur. 28		Final F.R.C.S. Examination (Ophthalmology and Otolaryngology) begins.
	10.00	Dr. K. W. Cope—Anæsthetics for Children.
	11.15	Dr. V. Toldman—Ethyl Chloride, Visthene.
	3.45	Dr. C. Howard Tonge—Anatomy of the Oral Cavity.
	5.00	Dr. R. Cruickshank—Hospital Cross-Infection.
	5.00	Dr. F. T. Evans—Anæsthesia for Perineal Surgery.
Fri. 29	10.00	Dr. A. J. H. Hewer—Anæsthesia in Cranial Surgery.
	11.15	Dr. G. Edwards—Basal Narcosis.
	3.45	Dr. C. Howard Tonge—The Deep Structures of the Neck.
	5.00	Dr. R. Cruickshank—Streptococcal Infection.
	5.00	Dr. C. F. Hadfield—Explosions—Preventions.

DIARY FOR NOVEMBER

Mon. 1		Final F.R.C.S. Oral Examination (Ophthalmology and Otolaryngology) begins.
	10.00	Dr. G. Organe—Assessment of Anæsthetic Risk.
	11.15	Mr. A. D. Marston—History of Anæsthesia.
	3.45	Prof. Wood Jones—The Muscles of the Body Wall.
	5.00	Dr. Cuthbert Dukes—The Surgical Pathology of Intestinal Tumours.
	5.00	Dr. P. J. Helliwell—Refrigeration ; Hypnosis : Electronarcosis.
Tues. 2		Final F.R.C.S. Examination (General Surgery) begins.
	3.45	Dr. D. V. Davies—The Middle Cranial Fosse.
	5.00	Dr. Cuthbert Dukes—The Surgical Pathology of Intestinal Tumours.
Wed. 3	5.00	Prof. R. Hare—The Staphylococci.
Thur. 4	3.45	Prof. H. A. Harris—The Nerve Supply of the Limbs.
Fri. 5	3.45	Prof. H. A. Harris—Clinical Anatomy of the Abdomen.
	5.00	Dr. R. J. Ludford—The Cyto-Pathology of Cancer.
Mon. 8		Final Fellowship Oral Examination (General Surgery) begins.
	3.45	Prof. G. A. G. Mitchell—The Autonomic Nervous System.
	5.00	Dr. R. J. Ludford—Malignant Growths in Tissue Culture.
Tues. 9	3.45	Prof. John Kirk—Topographical Anatomy of the Thorax.
	5.00	Dr. J. E. Cates—Renal Function.
Wed. 10	3.45	Dr. J. E. Cates—Renal Function.
	5.30	Annual Meeting of Fellows and Members.
	7.00	Monthly Dinner for Fellows, Members and Licentiates (see page 175).
Thur. 11	3.45	Prof. John Kirk—The Anterior and Posterior Abdominal Walls.
	5.00	Mr. L. E. C. Norbury—Bradshaw Lecture—Proctology Throughout the Ages.*
Fri. 12		D. A. Examination (Part I) begins.
	3.45	Dr. H. G. Hanley—Micturition.
	5.00	Dr. H. F. Brewer—Some Considerations Regarding Blood Transfusion.
Mon. 15	3.45	Dr. A. Schweitzer—The Reflex Control of Blood Pressure and Heart Rate.
	5.00	Dr. B. D. Pullinger—Cell Multiplication in Adult Tissues.
Tues. 16	3.45	Dr. A. Schweitzer—Measurements of Cardiac Output and Factors Influencing it.
	5.00	Dr. B. D. Pullinger—Cell Multiplication in Adult Tissues.
Wed. 17		D.T.M. and H. Examination begins.
	5.00	Mr. Geoffrey Keynes—Vicary Lecture—The Portraiture of William Harvey.*
Thur. 18	3.45	Prof. H. Barcroft—Blood flow in the Limbs.
	5.00	Dr. Keith Simpson—The Pathology of Blunt Head Injury.
Fri. 19		D. A. Examination (Part II) begins.
	3.45	Prof. H. Barcroft—Blood flow in the Limbs.
	5.00	Dr. Keith Simpson—Death fron Vagal Inhibition.
Mon. 22	3.45	Dr. F. K. Sanders—Results of Nerve Section.
	5.00	Prof. J. H. Dible—Inflammation and Repair.
Tues. 23	3.45	Dr. Cuthbert Dukes—Imperial Cancer Research Fund Lecture— The Significance of the Unusual in the Pathology of Intestinal Tumours.*
	5.00	Prof. J. D. Boyd—Development of Urogenital System.
Wed. 24	3.45	Prof. J. D. Boyd—Development of Cardiovascular System.
	5.00	Prof. E. C. Dodds—Sterol Metabolism—Pathology.
Thur. 25	3.45	Prof. E. C. Dodds—Sterol Metabolism—Physiology.
	5.00	Prof. J. H. Dible—Inflammation and Repair.
Fri. 26	3.45	Dr. N. H. Martin—The Applied Physiology of the Parathyroid.
	5.00	Prof. G. S. Wilson—Non-pulmonary Tuberculosis.
Mon. 29	3.45	Sir Cecil Wakeley—The Pancreas and its Relations.
	5.00	Dr. L. E. Glynn—Liver : Function Tests.
Tues. 30	3.45	Dr. B. Schofield—Digestion.
	5.00	Prof. J. Z. Ylung—Injury and Repair of Peripheral Nerves.

*Not part of courses.

RECENT ADVANCES IN THE TREATMENT OF ARM AMPUTATIONS, KINEPLASTIC SURGERY AND ARM PROSTHESES

Arris and Gale Lecture delivered at the Royal College of Surgeons of England
on
12th March, 1948
by
Leon Gillis, M.B.E., M.Ch., D.L.O., F.R.C.S.
Senior Surgeon Queen Mary's (Roehampton) Hospital and 'East Ham Memorial Hospital, London ·

EACH WAR OF THE 20th century has been followed by a renewed wave of interest in the technique of amputations and in the improvement and design of artificial limbs.

How true are the words of Sir Heneage Ogilvie :

" The ill winds of war have a habit to blow good to surgeons and through them to surgery."

The last two wars stand out as particular milestones in our knowledge and outlook on the management of amputations, and, above all things, in the reabling and the sympathetic consideration of the patient's ultimate welfare.

It is the purpose of this lecture to indicate to you some of the advances and changing trends.

Our aim to-day is a great deal more than the fitting of an absurd black-gloved wooden claw, a burden to the patient, and so often left merely to recline on the top of the cupboard, deceiving no one.

My talk is concerned with the problems of the upper extremity. The artificial limb here has a formidable, indeed an insuperable, task to compete with the miracle of the human hand, but progress comes not from despair.

The human hand has certain particular qualities, some of which no artificial hand can possibly attain :

(1) *Touch :* sensation to stimuli, such as heat and cold ; position sense.
(2) *Prehension :* the grasping power.
(3) *The intricate muscle movements* in its manifold permutations and combinations, of which the human hand is alone capable.

We try to imitate some of these lost functions :

(1) By operative procedure designed to utilise the remaining stump muscles as a claw, as in the Krukenberg procedure, or we utilise the remaining muscles as means for activating an artificial hand, as in Kineplastic procedures which I shall describe to you later.
(2) By operative procedure designed to prepare the unsuitable stump and thus render it more efficient and effective in the management of the prosthesis.
(3) By artificial appliances, not merely cosmetic, but with definite functional value.

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SOME OPERATIVE PROCEDURES

Let us first deal with some of the operative procedures. I want for a moment to draw your attention to a lesion in which the patient's arm is complete and viable but useless to him. I refer to the *Complete irrecoverable brachial plexus lesion.*

As is well known to you, the results after repair of the brachial plexus are poor, even in the best hands, and it is difficult, indeed often impossible, to dissect out the torn nerve roots and trunks from the matted mass of fibrous tissue.

After a varying period of from two years or more, the unfortunate patient is left with a heavy, immovable, partially insensitive useless limb, often ulcerating. The patient demands relief (Figs. 1 and 2).

Fig. 1   Fig. 2
Complete irrecoverable brachial plexus lesion with ulcerating useless arm.

It is to be observed that, fortunately, in most of these cases the scapular muscles still have an intact nerve supply. There is still control of the scapulo-thoracic movements by the Trapezius, the Rhomboids, the Levator Scapulæ and sometimes the Serratus Magnus (Fig. 3).

I have found the following procedure to be useful and well worth doing.

(1) *AMPUTATION COMBINED WITH ARTHRODESIS OF THE SHOULDER*

The arm is amputated about 6in. or 7in. below the acromion, and at the same operation an intra-articular arthrodesis is performed. The ulna bone in the amputated segment is dissected out and used as a graft for stabilising the arthrodesis.

Through a sabre-shaped incision (Fig. 4) the deltoid being already paralysed, the shoulder joint is opened up and denuded of the articular cartilage on the glenoid and the head of the humerus.
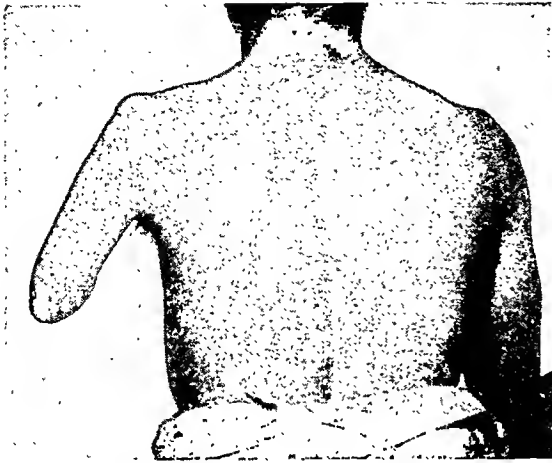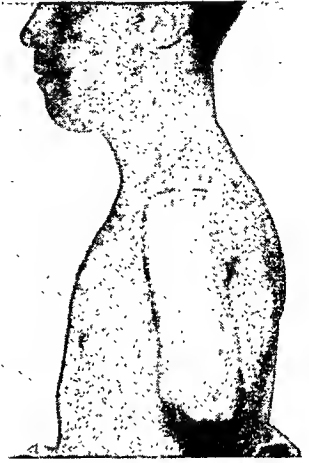
Fig. 3   Fig. 4

Complete irrecoverable brachial plexus lesion after arthrodesis with amputation.

The well-shaped ulna bone graft, about 5in. long, is then driven through the anatomical neck of the humerus into the head and well into the glenoid fossa.   The arthrodesis is fixed in plaster in about 45 degs. of abduction and 15 degs. of forward flexion (Fig. 5).

Fig. 5

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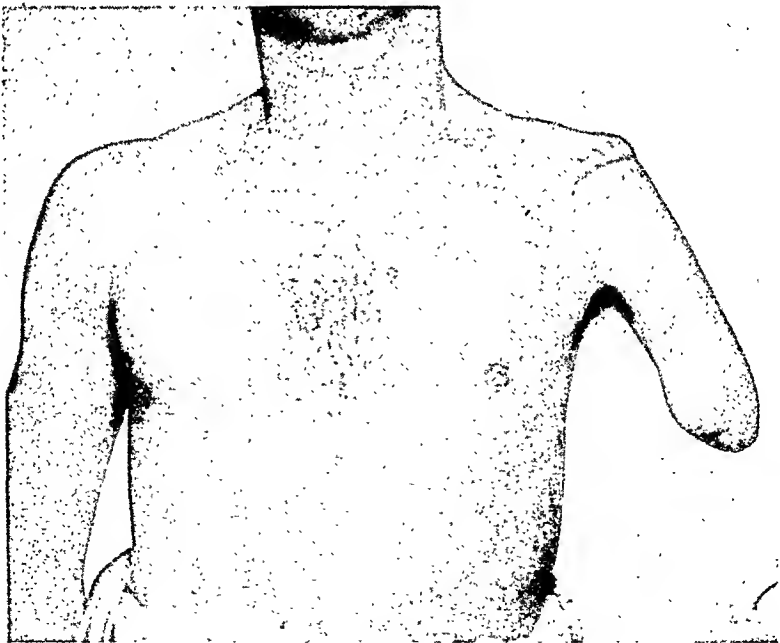
The stump is firmly arthrodesed in about six months (Fig. 6). These patients can then be supplied with an upper arm prosthesis which they can control by their remaining scapula muscles.

Fig. 6.   X-ray photograph of this case.

I have performed 12 such operations with success.   I would like to point out that I have similarly used bone grafts from the amputated segments for arthrodesing the hip-joint.

(2) KINEPLASTIC SURGERY

We now pass to consider further procedures often referred to as Kineplastic surgery.   Certain of the more distal amputations, e.g. forearm amputations, are wasteful in that they leave highly contractile muscle bellies intact but ineffectual and useless from the patient's point of view.

From time to time surgical endeavour has been stimulated to harness this waste of power.

The story of the development of this form of surgery is of interest.

During the Italo-Abyssinian campaign in 1896 some particularly horrible brutalities were committed.   Amongst these was the procedure of the Abyssinians to cut off the hands above the wrists of a large number of Italian prisoners.

Dr. Guiliono Vanghetti, a general practitioner of Empoli, in Tuscany, turned his thoughts to the development of surgical procedures to relieve these victims. He conceived the idea of so modifying the stump by operative measures as to enable the remaining muscles of the stump to be harnessed to a prosthesis and thus to actuate the artificial limb.

Dr. Vanghetti had little opportunity of putting his ideas into practice. His work was limited to experiments on fowls, but his writings stimulated surgeons like Ceci and Putti in Italy, and Sauerbruch in Germany. They gave his ideas practical shape.

These procedures have never proved popular in this country and there would seem to be need to review and maintain a flexible outlook on this subject.

The kineplastic muscle tunnel is simple in design and construction. It is formed by the elevation of a flap of skin of full thickness overlying the distal portion of the muscle to be used. The proximal and distal ends of the skin flaps are approximated and sutured to form a skin-lined tube. This is attached at one end for the maintenance of nutrition. The free end of the tunnel is reflected to expose the underlying muscle. The distal portion of the muscle is isolated and its insertion severed. A hole is made through the muscle belly just proximal to its tendenous portion, and so placed that between one-third and one-half of the muscle mass lies superficial to it. The skin tunnel is drawn through the hole in the muscle and is sutured to the outer side of the original incision. The tissues exposed, because of the removal of the skin in the form of the tunnel, are covered by a split-skin graft which is sutured around the edges of the original incision and to the superficial borders of the skin tunnel. The range of contraction is dependent upon the stiffness or elasticity of the skin and muscle.

This operation was extensively employed by the Germans under the stimulus of Sauerbruch, and I have seen a number of these cases both in this country and in America, and in my opinion the degree of control of the prosthesis is impressive (Fig. 7).

It has a particular value in patients who have lost both forearms and have very short or no upper arm stumps.

THE DYNAMICS OF MUSCLE ACTION

The revival of interest in kineplastic surgery has stimulated a great deal of work on this subject in the United States, whose surgeons and physiologists are studying this problem intensely, and I am grateful, particularly to our colleagues of the University of California, for giving me full facilities for access to their studies on the direct investigations upon such isolated human muscle bellies.

The surgical placing of skin-lined tunnels through the distal portions of muscles has made available to us isolated segments of human muscles for close physiological study.
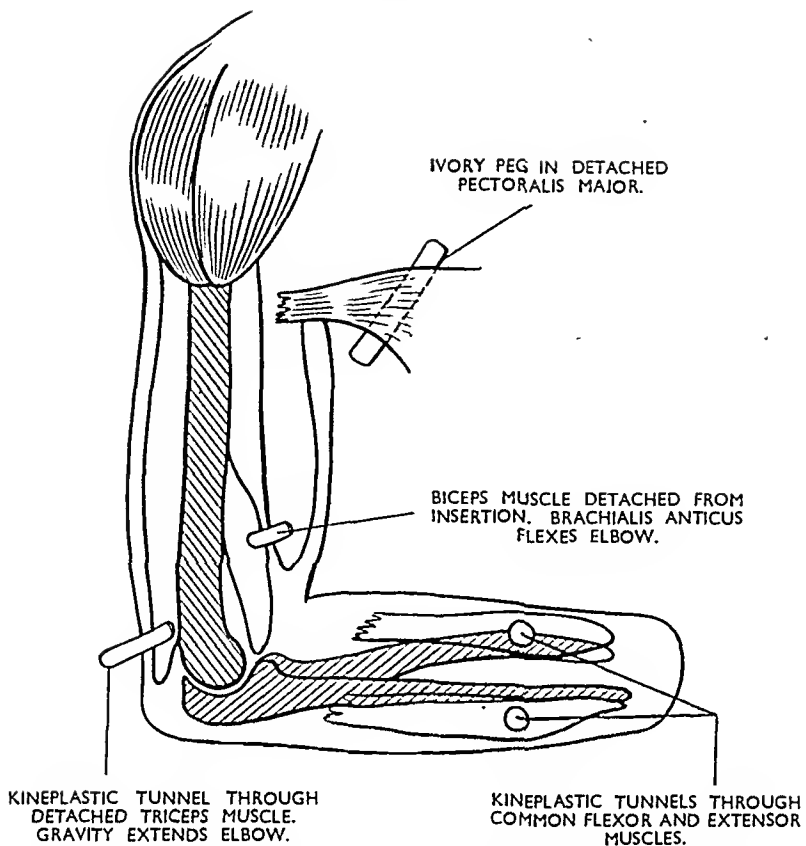
IVORY PEG IN DETACHED
PECTORALIS MAJOR.

BICEPS MUSCLE DETACHED FROM
INSERTION. BRACHIALIS ANTICUS
FLEXES ELBOW.

KINEPLASTIC TUNNEL THROUGH
DETACHED TRICEPS MUSCLE.
GRAVITY EXTENDS ELBOW.

KINEPLASTIC TUNNELS THROUGH
COMMON FLEXOR AND EXTENSOR
MUSCLES.

Fig. 7   Diagram showing the usual accepted sites for Kineplastic Tunnels.

It behoves the surgeon and the limb designer to have a fuller under-standing of some of the dynamic laws of muscle contraction. Let us consider for a while some of the physics concerned with this.

The human limb is powered by a system of articulated levers moved by muscles. Almost without exception the effective upper lever arm is short and the distal resistance lever long, i.e., the pull through which the muscle acts is short compared with the length of the resistance lever arm (Fig. 8).

The demands on muscle power are, therefore, enormous particularly when the distal lever arm is loaded. Such a mechanical arrangement would at first sight appear to be ill planned, but in fact it ensures the speed of action and the wide range of movement.

The muscle in order to achieve a wide range of movement has no need to pass into a complete state of slack but can adjust its range in virtue of minute alterations in the fibre length itself. The absolute amount that a muscle can be passively stretched and actively contracted depends upon the length of each individual muscle fibre. The longer the muscle the longer the fibre, and the greater the power. The corollary follows that the length of the individual muscle fibre will depend on the skeletal elements.
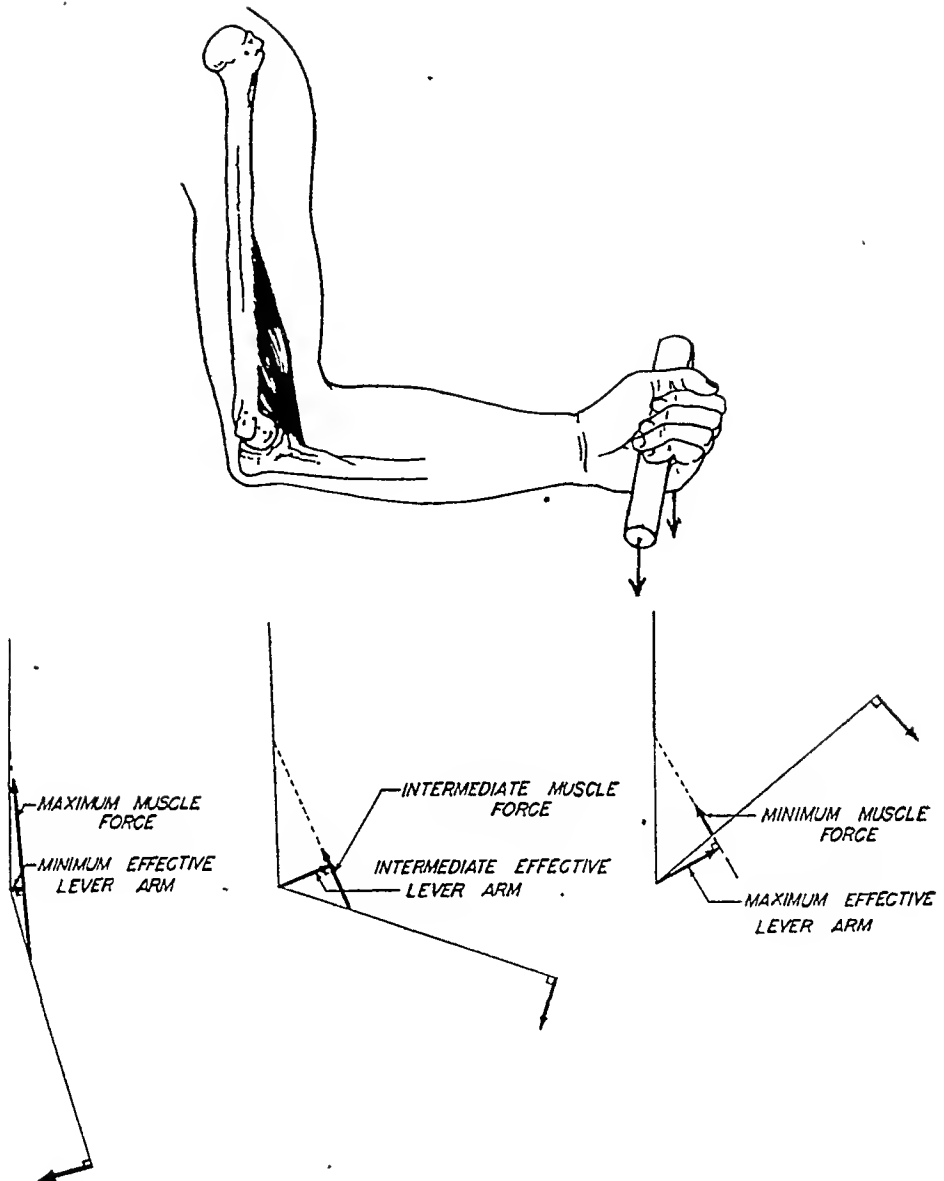
Fig. 8   Variations in Effective Lever Arm Vector Diagram for Brachialis Muscle.

It is obvious to us, therefore, that if we want to have the maximum power in a stump then we must retain every millimetre of bone and muscle. We must therefore review our present attitude in fixing elective sites for amputation in the upper limb.

Let me indicate a few more observations regarding the importance of muscle studies.

According to Weber, within one muscle the length of the individual muscle fibres are approximately the same, and the fibres in the human muscle system vary from 0.3in. to 18in. Haines estimated that when a

muscle in which the fibres are running parallel contracts it is shortened to 57 per cent. of the stretched length. In pennate muscle the excursion is less.

The kineplastic muscle tunnels have given us exceptional opportunities for the study of the dynamic laws of isolated human muscle bellies. For the first time it has been possible to study such action controlled under the direct volition of the subject; the pattern of neurostimulation is normal in contrast to the laboratory procedures, where the stimuli are of necessity artificial.

Our American colleagues have made intensive studies on such kineplastic limbs. Electromyography has been a valuable aid in such studies. They have determined firstly by a dynamometer using aluminium rings and strain gauges the varying forces in different states of muscle contraction. They were able to show that there were two types of muscle action confirming the experimental work of physiologists. Firstly, *Isometric type* of contraction without permitting appreciable shortening to occur and, secondly, *Isotonic contraction* in which shortening is permitted.

In kineplastic amputees both types of contraction are necessary to activate a prosthetic device. This confirmed our previous observations that as muscle length increased the force that could be developed also increased. The length of the fibres have been measured by Weber.

I have already indicated to you that Haines estimated that a muscle on full contraction shortens by 57 per cent. of its length. We will compare the data derived from the kineplastic muscle tunnels with the maximum theoretical excursion.

The calculated theoretical excursions are contrasted with the experimental excursions obtained from the study of these kineplastic tunnels.

TABLE I

Muscle	Average Fibre Length (Inches)	Maximum Theoretical Excursion (0.57 × Fibre Length in Inches)	Average Experimental Values (From Kineplastic Tunnels) (Inches)
Biceps brachii ..	5.1	2.9	2.5
Brachialis	3.5	2.0	
Triceps brachii ..	3.1	1.8	1.7
Deltoid	3.6	2.0	
Pectoralis Major ..	6.0	3.4	4.3
Trapezius	4.3	2.4	
Latissimus Dorsi ..	8.0	4.6	
Average of Flexors of Forearm ..	2.5	1.4	1.0
Average of Extension of Forearm ..	2.4	1.4	0.7

It will be noted from Table I that, with the exception of the Pectoralis Major, the theoretical excursion was not attained in the muscles having tunnels, although the two values are reasonably close. The Pectoralis

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Major exceeds the theoretical value due in part to its low resistance to stretch, thus permitting elongation beyond a physiological range in the determination of the experimental values.

Obviously it is desirable to harness the maximum power to activate the prosthesis, and to assist the amputee force multipliers have been constructed. From these studies it is clear that kineplastic muscle tunnels can serve in a fashion best calculated to move an artificial hand, e.g., actively, voluntarily and in a manner approaching the function of the natural limb.

Kinetization in upper extremity amputations has definite and important advantages. The prosthesis seems to become a part of the patient. He readily appreciates that with a will to strive, success will come and he joins eagerly in response to the enthusiasm of the surgeon. As in the fitting of all such activated upper-arm prostheses the choice of the patient is an important consideration. He must have a mind prepared and willing to accept it. It is no mere cliché to say that the prosthesis should snugly fit the mind as well as the stump.

If this operation has value you will ask why it has not been universally employed. There are several reasons :

(1) These plastic tunnels are not as easy to prepare as the pictures indicate. They were tried out after the First World War but the skin became excoriated and broke down. They were thus rendered incapable of further use, but we have to bear in mind that plastic surgery has made great strides since then, and in the hands of a plastic surgeon this is not an obstacle to-day.

(2) While great strides have been made in the improvement of the kineplastic prosthesis, the lack of a perfected model is still one of the great obstacles.

(3) Amputations in the past have often been performed with no consideration as to the possibility of utilising the remaining muscle bellies.

(4) A large number of amputations went septic with great muscle destruction and consequent fixation. In the last war, due to the advances in Chemotherapy, sepsis has not been a major factor.

(5) Further, as we shall see later, in this country there is now being developed a prosthesis which is activated by the shoulder muscles and which gives the patient remarkable control and power, and might spare him the necessity of further operations. At the present moment, however, it cannot be adequately employed for any above-elbow amputation, and I am of the opinion that there is no comparable alternative to kinetization for the short-arm amputation case.

(3) THE KRUKENBERG OPERATION

Kineplastic surgery *per se* can only give the faculty of prehension and not that of tactile sensibility.

The object of the Krukenberg operation is to convert the radius and ulna into the two jaws of a " crocodile " forceps.

The following is a description of the method :

Incision. The line of incision is kept close to the ulna and begins on the volar surface of the forearm at a point 7cm. distal to the bend of the elbow. From thence it passes longitudinally and turns round the end of the stump to a point at the same level on the dorsal surface. This gives a " U " shaped cut which is deepened so as to separate the flexor digitorum sublimis into a radial and ulnar moiety.

Resection of Nerves and Muscles. The median and ulnar nerves are cut short, taking care not to damage their branches to useful muscles. The flexor pollicus longus and the flexor digitorum profundus are entirely resected in order to make the two jaws of the forceps less bulky and more easy to clothe with skin.

Division of the Interosseous Membrane. This membrane is divided for a sufficient distance to obtain a separation of 12cm. between the ends of the radius and ulna. In making this cut the knife should be kept close to the ulna, and the interosseous arteries should if possible be spared.

Treatment of the Bones and remaining Muscles. The radial moiety of the flexor sublimis is sutured to the flexor carpi radialis, and the ulnar moiety to the ulnar flexors. The extensors are similarly united into radial and ulnar groups. The extremities of the radius and ulna are freshened by removing a centimetre of bone from each shaft and their ends are grooved. The radial flexors are joined with the radial extensors in such a way that the junction between them lies in the groove at the end of the radius ; the ulnar flexors and extensors are similarly dealt with (Fig. 9).

Skin Closure. Owing to the ulnar position of the skin incision, closure is easily effected round the radial jaw of the forceps. A raw area remains on the ulnar part, and this is grafted, either at once or later, by means of a pedicled flap cut from the abdomen.

Movements are begun as soon as healing is complete, and are supplemented by the usual routine of massage and electrical treatment.

Abduction of the radial limb of the forceps is produced by the brachioradialis muscle, the flexor carpi radialis, and one-half of the flexor digitorum sublimis, and adduction is produced by the pronator teres, flexor carpi radialis, and the other half of the flexor digitorum sublimis.

There have been many objections raised to the operation. Let us therefore, evaluate them.

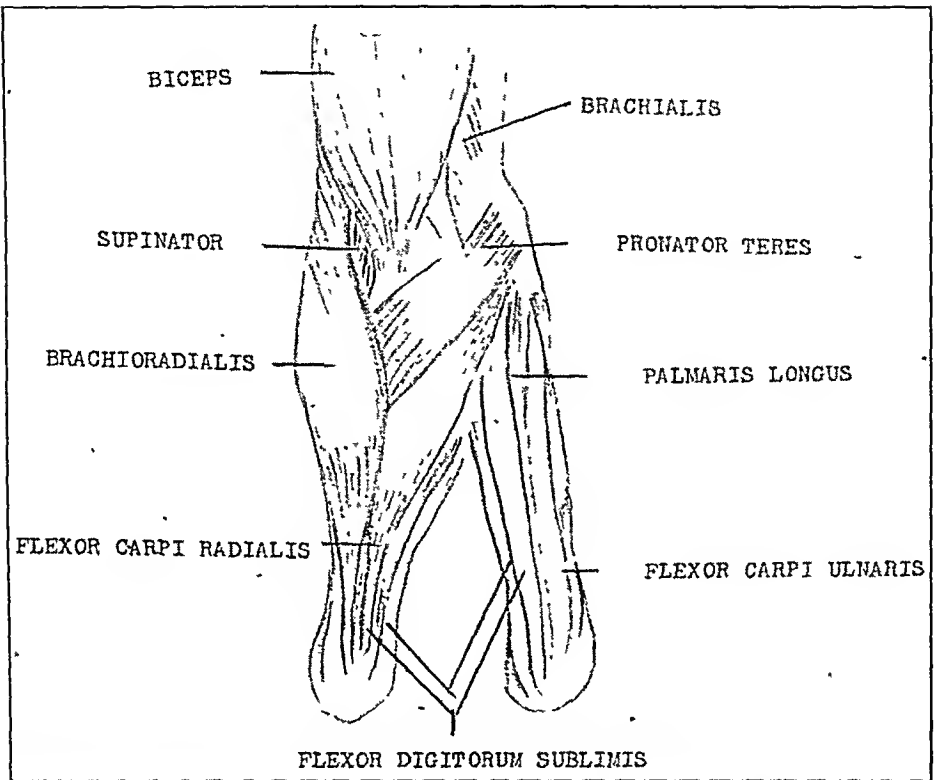Firstly, the stump is considered by some to be unsightly (Fig. 10).

Fig. 9. Diagram showing the distribution of the muscles of the forearm in a Krukenberg operation.

Fig. 10. Bilateral Krukenberg " claw," writing.

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After the First World War a British soldier was subjected to the operation while a prisoner of war in Germany. When he returned to this country his case was reported in the newspapers as an example of German atrocities on prisoners of war.

It should be remembered that medical men regard anatomical anomalies differently from the general public. The people I have spoken to have disliked the appearance of the Krukenberg arm.

On this point, should we not consider first, last and all the time, the patient's reaction rather than our own surgical enthusiasms. To date there is no indication that the people in this country would accept this procedure—those to whom it has been offered have refused.

The second objection, that the Krukenberg precludes the wearing of an artificial limb, cannot now be held valid, for any of the standard prostheses can without difficulty be fitted to a Krukenberg stump.

The third objection, that a man with a forearm stump is capable of doing more with a prosthesis than with a Krukenberg stump may be true, but it should be remembered that comparisons depend upon the skill with which the patient uses either his Krukenberg or his artificial prosthesis, and again, it must be borne in mind that the type of employment is important (Fig. 11).

Fig. 11. Bilateral Krukenberg " claw " turning over pages of a book.

The Krukenberg patient finds it as easy to make use of his forearm prongs as the ordinary patient to learn to use his prosthesis, but again, this will depend on the diligence with which the latter patient applies himself to his task.

There are two advantages of the Krukenberg procedure:

(1) The patient is spared the trouble of putting on an apparatus and he retains tactile sensation. The retention of sensation is of inestimable value in the case of the blind. The Krukenberg would thus seem to be indicated for blind double-arm amputees (Fig. 12).
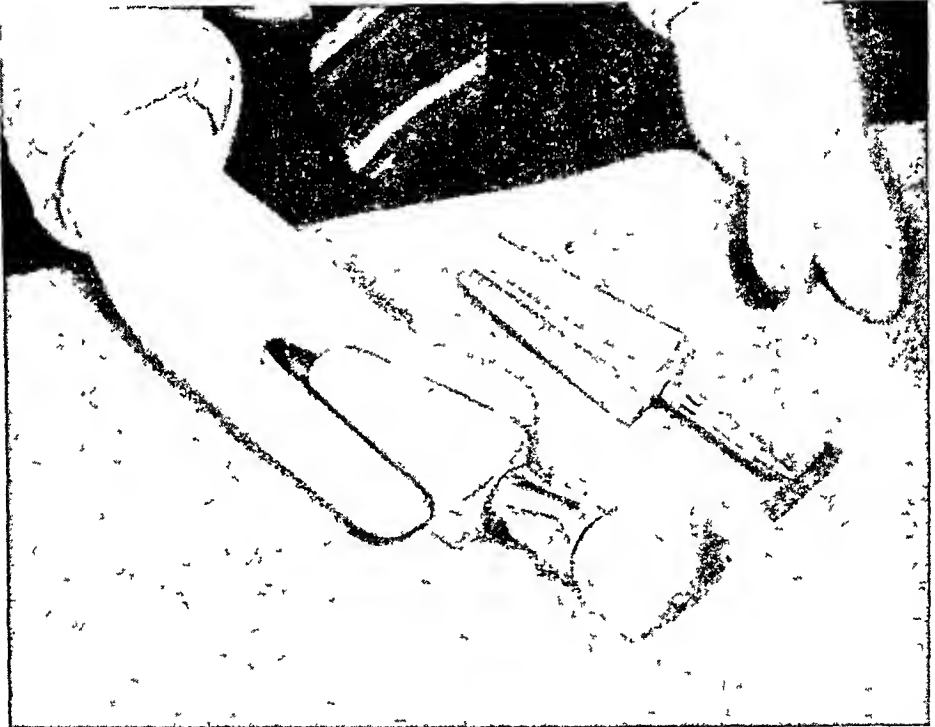
Fig. 12. Bilateral Krukenberg " claw " showing method employed for toilet.

(2) The Krukenberg operation has a definite place in the surgery of people in remote places where there are no facilities for prosthetic appliances and where their only alternative is a useless stump. These people may not be able to afford a prosthetic appliance and if possessed of one may not be able to keep it in good repair.

(4) *NEOARTHROSIS OF THE SHAFT OF THE HUMERUS*

Next I would like to tell you of the operation of Neoarthrosis of the shaft of the humerus. This operation has value in amputations of the upper limb when the function of the elbow-joint is lost.

The loss of an arm in a manual worker is obviously much more serious than the loss of a leg, but it is doubly serious when the elbow-joint is lost, as the loss of the natural movements performed at that joint can only very imperfectly and very inadequately be accomplished by even the best prosthesis, and then even with considerable difficulty, so that a below-elbow prosthesis is a consummation greatly to be desired.

A school teacher, both of whose hands had been amputated when he was six years old, had learned to be absolutely independent, and had passed his examination entitling him to a Teacher's Certificate. Without an artificial limb he could dress himself, shave, eat with grace and assurance, write an unusually legible hand with more than average rapidity, travel long distances alone, pay his fares, just as the normal individual. All this in virtue of the fact that he still had both his elbow joints intact.

So much has the importance of the elbow joint been impressed upon us at Roehampton, that every endeavour is made to save at least a few inches of the forearm. The Limb-makers, with the close and active co-operation of the Limb-fitting Surgeons, have with patience and ingenuity succeeded in producing a limb that can be fitted to an extremely short forearm stump, even one as short as $1\frac{1}{2}$in., below the insertion of the biceps tendon.

There remains, however, a residuum of cases in which either because of the site of the original injury or disease, or because of sepsis, it is necessary to amputate at a level that involves the loss, either functional or anatomical, of the all-important elbow-joint.

Hitherto, it has been the custom in such cases to amputate at the so-called site of election, which frequently involves the loss of healthy skin, muscle and bone, and it was this loss of sound tissues that first made me wonder whether some use could not be made of them; so the idea was conceived of constructing a simple joint in the shaft of the humerus at the site of election for amputation, with a short distal stump that could be made to function as a forearm controlled by the powerful flexor and extensor muscles that normally control the movements of the natural forearm.

So far as one could see, nothing could be lost by this procedure except time and, if the newly created joint proved a failure, the joint having been made at the site of election re-amputation could still be carried out, without any further loss of tissue than would have been the case had the usual amputation been undertaken in the first instance.

My efforts, however, to produce a satisfactory new joint were at first foiled by the formation of exuberant callus and the subsequent ankylosis of the false joint.

Several methods (shown in order of adoption in Fig. 13) were tried. It was found that great care in fashioning a replica of a joint failed

because of the rapidity with which the bone threw out callus and caused fixation despite the fact that :

1. The bone was divided more or less transversely at a point usually considered common for non-union, and

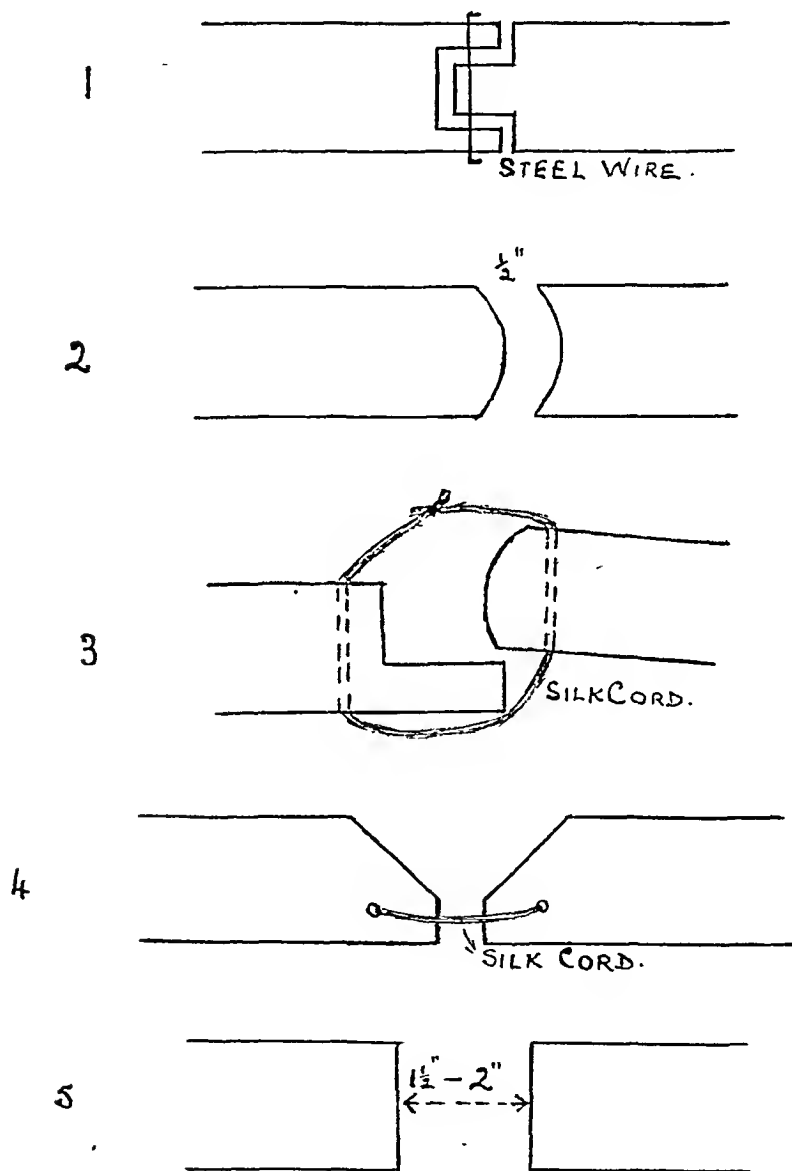2. Movements were commenced within a few days after the operation.

Fig. 13.
Illustrations 1-5, showing the stages through which the operation has progressed to date.

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Finally, however, the following methods were evolved and have proved to be satisfactory:

(1) The re-section extraperiosteally of 1½in. to 2in. of the shaft of the humerus at the proposed site of the new joint. After this, burning of the bone ends by electro-cautery was regularly performed to ensure non-union.

I subsequently learned that it was over 100 years ago that Charles Bell, who delivered an Arris and Gale lecture, said:

" Scrape a bone and its vessels bleed ; cut a bone and its granulations sprout up ; break a bone and it will heal ; cut a piece away and more bone will readily be produced ; burn it and it dies."

(2) I packed the resulting cavity with 10-15 grms. Sulphanilamide powder further to prevent union. Sulphanilamide in high concentrations inhibits phosphatase activity.

(3) Immobilisation of the arm in a straight plaster cast for two weeks at least, and reduction of muscle activity to a minimum.

The plaster cast being removed in about 14 days and active movements commenced, the patient readily achieves a range of 90-deg. of flexion at the new elbow-joint and this, it will be appreciated, is an extremely valuable range of movement, especially in double-arm amputees (Fig. 14).

Movement of the new elbow-joint, fitted with a temporary prosthesis, which is a very comfortable apparatus. Note also the lessened arc of flexion and its obvious value (Fig. 15). The patient soon develops a powerful controlled elbow flexion which he can utilise for carpentry or his ordinary work (Figs. 16 and 17).

Arm Prostheses·

The demands of modern industry and commerce make it imperative that employees should be able to hold their own with their normal fellow-men. At the outset we must accept the fact that the man who has lost a limb is handicapped industrially, but his handicap is not so severe that he cannot be an asset to himself and his employer.

A working day spent among men who have undergone an amputation and who use the attachments to be described, would convince employers that such men can fill useful places in industry and commerce.

Generally the man does not ask for consideration on account of his handicap, though naturally he is sensitive about it. With a properly fitted arm he can do his work and retain his self respect (Fig. 18—page 244).

If a man who has lost an arm is to hold his own with other workers, it is necessary that his artificial limb should enable him to use tools or other equipment with the same degree of skill as his fellow workers. This end is being attained by the use of properly designed artificial arms, together with various attachments that can be fitted to them. It is important to enquire into the occupation which the man had before his injury. The modern practice is to supply a particular type of arm for use in particular employments. For instance, if a man is to take up heavy
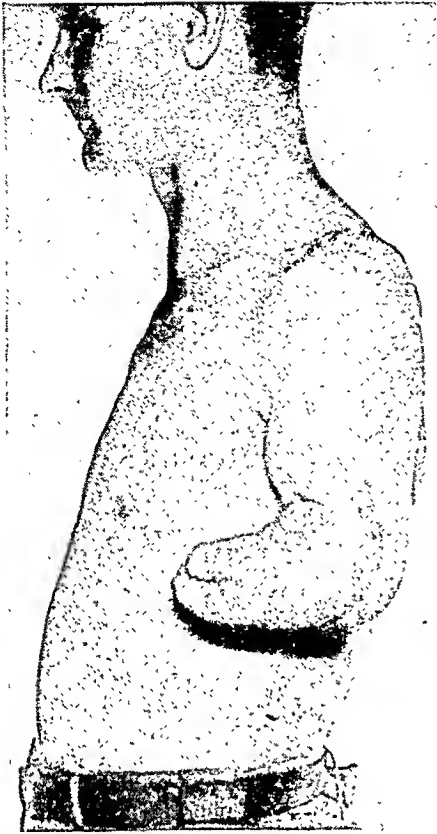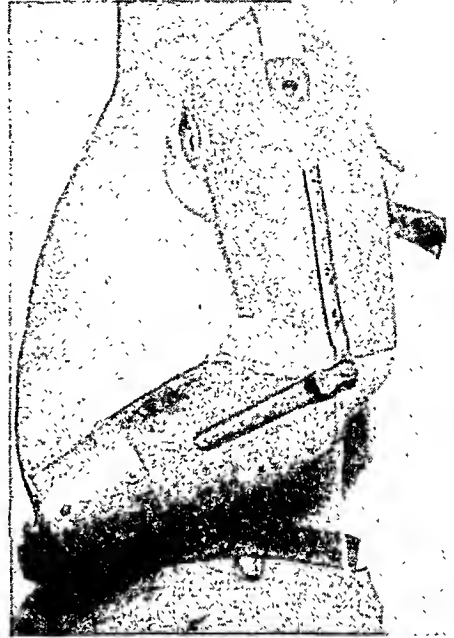
Fig. 14

Fig. 15

Fig. 14. Neoarthrosis of the shaft of the humerus. Flexing new forearm.

Fig. 15. Neoarthrosis of the shaft of the humerus. Wearing a prosthesis.

Fig. 16

Fig. 17

Fig. 16. Neoarthrosis of the shaft of the humerus (painless and powerful movement).

Fig. 17. Neoarthrosis of the shaft of the humerus, showing the power which can be attained.
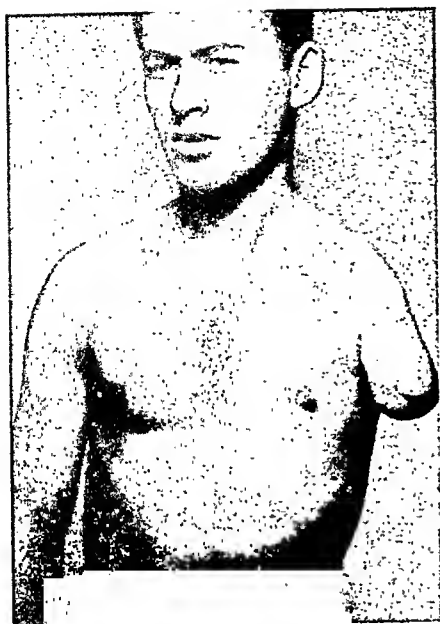
Fig. 18.   Prosthesis supplied for gun-shot wound of the shoulder with amputation and loss of contour of the shoulder.

work, it is possible for him to obtain from his arm-fitting centre a heavy duty type of arm, and so on.

Attachments to the arm have been developed for many diverse purposes. Some are only for special tasks, but others have a more or less universal application.

Attachments for Artificial Arms

(1) *The Split Hook.*—The split hook is the most generally useful attachment so far invented. It is simple in construction and can be used with great dexterity by both single and double amputation cases. It is opened and closed by movement controlled by the flexing of the shoulders. Like all other fitments, this is made either to plug straight into the arm or to screw into an adaptor.

(2) *The Universal Appliance.*—The Ministry of Pensions universal appliance has proved to be one of the best of the modern appliances, valuable for the out-door worker and for many in-door tasks.

After removal of a limb the need for a substitute became self-evident. In response to this necessity the Limb-maker became closely associated with the surgeon.

For centuries now, man has set himself the task of trying to imitate the human hand without much success. The result was that, in this country, which undoubtedly leads the world in artificial appliances, the mechanical hand was given up. It was replaced by fitments as described, or a series of mechanical appliances which enable the amputee to accomplish a particular task with a suitable appliance for that task.

(3) *The Mechanical Hand.*—The mechanical hand, which I am about to demonstrate, and in which I have co-operated, has recently been devised at Roehampton, and has the following main features :

In grasping an irregular object the fingers conform to the shape of that object. The grasping of the object can be obtained by the merest shrug of the shoulders. No tension is required for the object to be maintained in the hand as the fingers can automatically lock. If it is thought that the grasp on the first attempt is not sufficient, another shrug further tightens the fingers on the object. Instantaneous release is afforded by fractional bend of the elbow or by pressure being applied to the special release lever fixed to the inner aspect of the socket.

The hand can be used to grasp objects without employing the automatic locking device (Fig. 19). This hand has so far been developed only in relation to forearm amputations, but controls are in the process of being devised which might enable the hand to be used also in relation to above-elbow amputations.

In conclusion it can be stated that the hand is detachable from the arm, enabling the amputee, therefore, to use any other special appliance if desired. No mechanical hand hitherto produced possesses this feature.

Much depends upon the patient himself. Whether we employ kineplastic or other devices, such as the split hook or the mechanical hand, we should select the one which best fits the needs of the specific case.

Fig. 19.   Artificial hands employed for various tasks.

It behoves us to decide what is best for the patient, not only for his stump but his whole personality, bearing in mind the psychological and vocational as well as the economic aspects of the case.   We should pay less attention to, and be less influenced by, the achievements, often spectacular, of the paid and highly skilled demonstrator and more to

results obtained by the average man. It is well to remember the saying :
" A clever spinner spins with an ass's foot."

May I take this opportunity of thanking the President and Council of the College for the honour and privilege they have afforded me in allowing me to give this lecture.

To Dr. Prideaux, C.B.É., Director General of Medical Services of the Ministry of Pensions, my thanks are due for his enthusiastic support.

I feel a debt of gratitude to two great leaders of two of the largest Limb Factories in the world, Mr. A. W. Shaw and Mr. Hugh Steeper, for their ever readiness to help me and to foster the scientific improvement of artificial limbs.

To Dr. Russell Reynolds I owe much for his help in cineradiography.

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SURGERY OF PEPTIC ULCER·

Lecture delivered at the Royal College of Surgeons of England
on
18th March, 1948
by
Rodney Maingot, F.R.C.S.
Surgeon, Royal Free Hospital, London

IT IS BECOMING customary to class gastric ulcer and duodenal ulcer together as one disease. Admittedly they have certain features in common, in that their causation is probably the same, the methods employed for their diagnosis are almost identical, and the early signs and symptoms presented by the two conditions are in many respects similar, as are also the medical measures advocated for their treatment, thus rendering it impossible to discuss one disease without constantly referring to the other. Therefore, from many points of view they may be regarded as allied affections—peptic ulceration.

On the other hand, the risk of malignant transformation, the degree of morbidity, the potentialities of disaster, and the associated economic disturbances are factors which differ widely according to whether they are associated with duodenal ulcer or with chronic ulcer of the stomach. Furthermore, the surgical treatment of the two conditions varies in many essential details, and it is for this reason in particular that I propose to discuss them separately.

(A) DUODENAL ULCER

The surgery of duodenal ulcer is concerned primarily with the complications which may arise during the course of the disease. These complications are acute perforation, hæmorrhage which threatens life, and pyloric obstruction. Another indication for operative interference. is intractability. There are many definitions of the word intractability. Whilst it is commonly used by physicians to imply the failure of medical treatment, it also aptly describes the patient who has lost patience with his symptoms and with his treatment. An ulcer may therefore be said to be intractable when it can no longer be tolerated by the patient.

Medical Treatment

The principles of medical treatment may be outlined as follows :

(1) *Mental and Physical Rest.* One of the greatest problems in connection with medical therapy is the question of ambulatory or bed treatment. I believe that as soon as a diagnosis of chronic duodenal ulcer is made, the patient should be admitted to hospital and be put to bed to ensure the maximum degree of mental and physical rest. Bed treatment is the most important item in the management of these cases. Hospitalization makes it possible to educate the patient in the care which he will need to exercise to procure sound healing and prevent recurrences. Furthermore, it provides the most favourable opportunity for adequate neutralization of acid.

(2) *Neutralization of Acid.* This is effected by a well-balanced bland diet rich in vitamins and assimilable proteins and by the administration of alkaline powders or draughts. As much neutralizing medication is prescribed as is necessary to produce complete neutralization *at all times.* No form of therapy effects this object more satisfactorily than *the milk-drip method* originally introduced by Einhorn (*Med. Rec.*, **78** ; 92, 1910) and popularized by Winkelstein (*Amer. J. M. Sc.*, **185** : 693, 1933). A Ryle tube is passed through the nostril into the stomach, and the proximal end is attached by means of a glass tube and rubber connection to a reservoir containing milk or milk substitute. This container is slung to an upright support about 3 feet or so above the patient's head. The milk, which is diluted and to which may be added alkaline medicines, vitamins A, B and C, atropine or amino acids, all in appropriate amounts to suit the individual requirements of the case, is run in at a slow and even drip—about 40 drops per minute—by day and by night so that approximately 5-6 pints are introduced into the intestine in each 24 hours. The milk-drip is continued as long as it is required—days or weeks— and ensures adequate neutralization by day and during the critical hours of the night when gastric secretion is at its height.

(3) *Removal of Irritating Elements which produce Spasm and Hyperacidity.* The importance of smoking as an irritating factor is well recognized, and it ranks with fatigue and tension as the most frequent cause of recurrence. Alcoholic beverages, however disguised, are banned. Atropine is prescribed to relieve spasm, and luminal to assuage anxiety.

Patients who have undergone an efficient course of medical treatment in hospital—and by efficient I mean prolonged, systematic, well-supervised and disciplinary—should be checked at intervals, both by means of X-rays and by gastric analysis, and are ordered a special post-ulcer regime. I agree with Jordan (*Surg. Clin. N. Amer.*, p. 665, June 1941) that the so-called ulcer-life, with the elimination of smoking, alcohol, indiscreet eating, late hours and fatigue (worry syndrome), is indispensable to stomach integrity in the individual with an ulcer diathesis.

The following groups of patients who have chronic duodenal ulcer should receive *medical treatment :*

    (1) All those who have uncomplicated ulcers, especially if they have been present for only a short time.

    (2) All patients of 30 years of age or under, unless their lesions are complicated.

    (3) All older patients in whom the symptoms are mild and do not impair their efficiency.

    (4) Any patient whose ulcer is complicated by some medical condition which would render operation hazardous.

    (5) Psychoneurotic patients who have hyper-irritable gastro-intestinal tracts, whose ulcers are not complicated by deep penetration to the pancreas, repeated hæmorrhage or obstruction.

Statistics of permanent cure of duodenal ulcer by medical treatment do not give a higher valuation than 50 per cent. (Coneybeare, *Lancet*, **2**, 1017, 1935). Heuer (*The Treatment of Peptic Ulcer*, 1944) states that less than 50 per cent. of his cases did well on medical treatment, and that 3·5 per cent. of those patients treated medically died directly from the ulcer. Gainsborough and Slater (*B.M.J.*, **2**, 253, 1946) consider that the results of medical treatment are disappointing, and on their figures fully one-third of the patients can be expected to relapse within four months. Well over one-half of their patients had relapsed within one year of discharge from hospital.

Indications for Operation

These may be listed as follows :
- (1) Acute perforation.
- (2) Intermittent or continuous hæmorrhage coming from the base of a chronic duodenal ulcer which medical therapy is incapable of controlling.
- (3) Pyloric obstruction due to a long-standing cicatrising duodenal ulcer.
- (4) Intractability—failure of medical treatment.
- (5) Recurrence of ulceration associated with severe symptoms following : (*a*) simple suture of an acute perforation, or (*b*) an inadcquate operation such as pyloroplasty.
- (6) Chronic penetrating duodenal ulcer accompanied by a chronic gastric ulcer.

Perforation

As soon as the diagnosis of acute perforation is made, a Ryle tube is passed through the nostril into the stomach and all the gastric contents are aspirated. This prevents any further contamination of the peritoneal cavity. The tube is left in s'tu, and intermittent suction is applied during the operation and for the first 2-3 post-operative days.

The object of operation is to save the patient's life by a safe and expeditious procedure. The operation, which fulfils this requirement, is simple suture by the method advocated by the late Roscoe Graham (*Surg., Gynec. and Obst.*, **64**, 235, 1937).

Three sutures are passed, one through the margins of the ulcer, one above and one below. Then, after drawing a generous amount of great omentum over the perforation, the sutures are securely tied, thus sealing off the perforation. Operations such as excision of the ulcer, gastro-jejunostomy or gastrectomy, should not, in my opinion, be performed in the presence of this catastrophe (Fig. 1).

When the patient is convalescent, or some months later during the tranquil period of medical treatment, the case can be reviewed, and, if surgery is clearly indicated, the appropriate operation can be performed under the most favourable conditions.

The late results of simple suture of a perforated duodenal or gastric ulcer are poor, as over 70 per cent. of the cases have crippling symptoms, and some 50 per cent. of these have eventually to be subjected to re-operation.
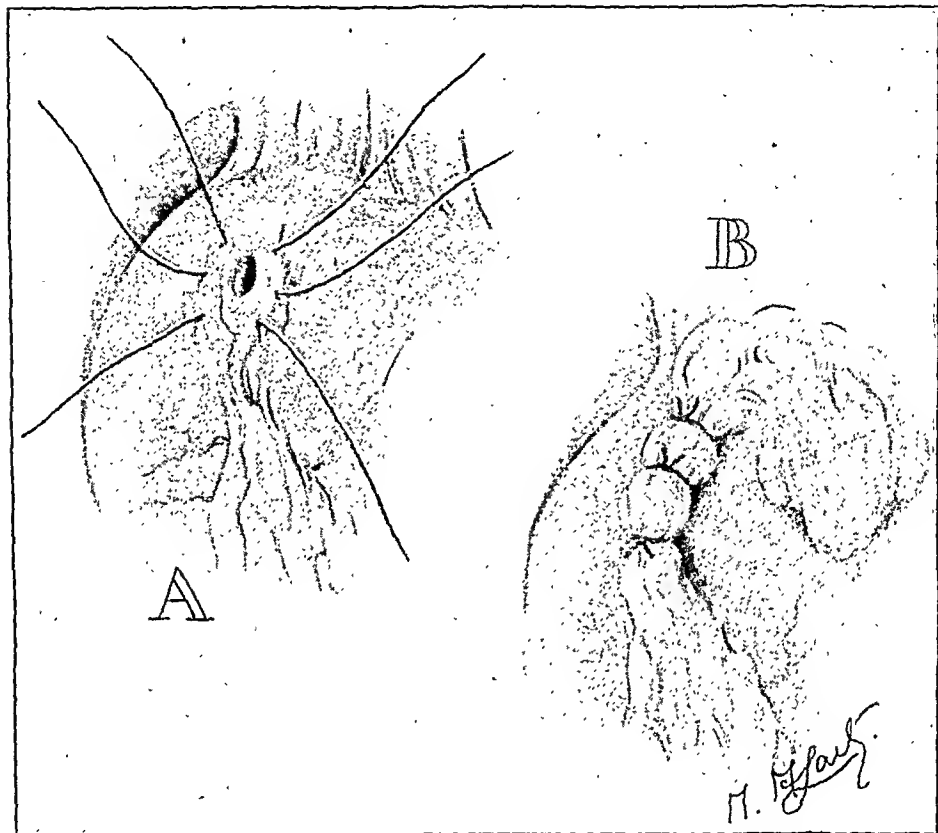

Fig. 1
Closure of a perforated duodenal ulcer by the three-suture method of Roscoe Graham.

Hæmorrhage

The treatment of the bleeding ulcer may be medical or surgical. In most cases medical therapy is the one of choice. The prognosis is best in patients under the age of 45 and in women. It is grave in the aged and in those with large penetrating lesions.

Medical treatment is instituted in all cases in which massive bleeding occurs from a callous ulcer of the stomach or duodenum. If there is evidence of continued or recurrent hæmorrhage after medical therapy has been carried out for 48 hours, it is my view that a surgical attack should be made upon the ulcer without further delay. The patient is given an opportunity to respond to conservative treatment, but if this response is not satisfactory in 48 hours, I would advise immediate laparotomy.

It must be emphasised that operation should be undertaken only in definite cases of ulcer. Perhaps the most obvious indication for early operation is massive hæmorrhage in a hypertensive patient over the age of 50, who is known to be suffering from a chronic gastric or duodenal ulcer, who is not responding promptly to blood transfusion and the Meulengracht regime, and in whom bleeding recommences within 24-48 hours of the initial hæmorrhage. Late operation in àn exsanguinated patient is the forlorn undertaking of a harassed surgeon. Arresting the hæmorrhage at this late stage cannot repair the damage to the parenchymatous organs, especially the kidneys and liver, which is occasioned by prolonged anæmia.

When operation is indicated in cases of *bleeding gastric ulcer*, the surgeon has a choice of two procedures : (1) detaching the ulcer from its sclerotic base and closing the hole in the stomach, or (2) performing partial gastrectomy. The former operation is reserved for the desperate case and the latter for the expert.

The operative treatment of *bleeding duodenal ulcer* may entail partial gastro-duodenal resection or else exposure of the ulcer through an incision in the anterior wall of the duodenum and adjacent pyloric zone, followed by transfixion of the ulcer base with strong silk sutures. There is no operation which will afford greater protection against recurrence of immediate or remote hæmorrhage than resection, more particularly when this is combined with vagotomy. When, therefore, the patient can be operated upon within 48 hours of the onset of bleeding, when he appears to be in a satisfactory condition, when the duodenum can be mobilised and the ulcer is not too large or too firmly fixed to the underlying head of the pancreas, partial gastro-duodenal resection should be performed.

When resection is considered too hazardous, the ulcer should be exposed by an ample incision through the anterior duodenal wall and pyloric sphincter, the edges of the wound held apart with Allis forceps, and four cross-mattress sutures of strong silk inserted deeply through the edges and base of the ulcer and tied very tightly (Fig. 2). This controls the bleeding, obliterates the ulcer, and is, in my opinion, the most efficient emergency method of dealing with the bleeding artery.

The wound in the anterior wall of the duodenum and pylorus is then closed transversely, but if, owing to the scarred condition of the bowel wall, this is not possible, then the adjacent edges of the stomach and duodenum are approximated with a three-tier suture and protected with an omental graft.

Gastro-jejunostomy has no place in the treatment of bleeding gastric or duodenal ulcer.

Obstruction

The commonest cause of pyloric stenosis is a cicatrising duodenal ulcer. We have to distinguish between organic pyloric stenosis due to
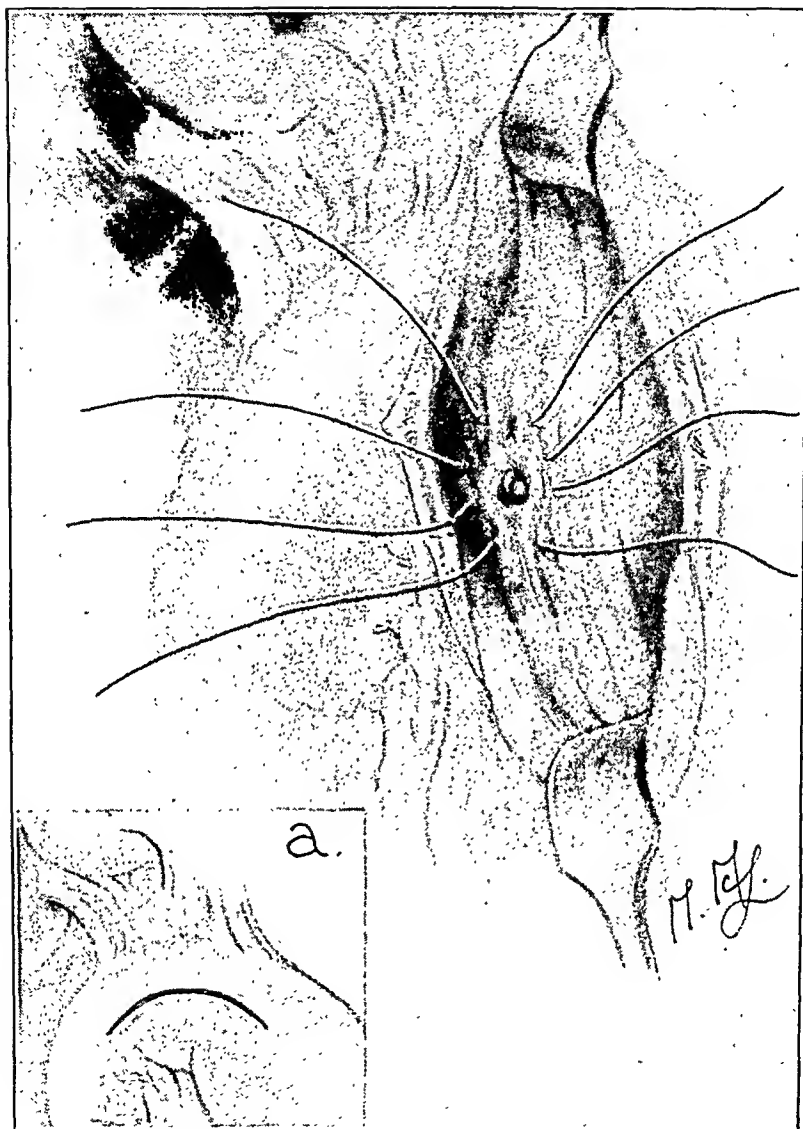
Fig. 2.

Bleeding duodenal ulcer. Method of arresting the hæmorrhage from a duodenal ulcer by incision of the anterior wall of the duodenum and adjacent pylorus, and the insertion of a series of sutures which, when tied, will obliterate the ulcer and thus secure adequate hæmostasis.

scar formation, and spastic obstruction due to inflammation and œdema around the ulcer. The latter condition may be amenable to good medical therapy, the former is not. I used to be taught that pyloric stenosis due to a duodenal ulcer was a clear-cut indication for gastro-jejunostomy. Long-standing scar stenosis in an elderly patient with permanently low acid values in the gastric juice is an indication for a short-circuiting operation, but stricture of the duodenum due to chronic ulcer associated with hyperacidity calls for gastric resection.

The Irremovable Duodenal Ulcer

It is true that with practice and painstaking dissection most chronic ulcers can be excised, or at least the pylorus and a variable portion of the first part of the duodenum can be cleared, divided, and closed in a watertight fashion, even if the crater is left behind embedded in the substance of the pancreas (Figs. 3 and 4).

ANTERIOR POLYA-HOFMEISTER
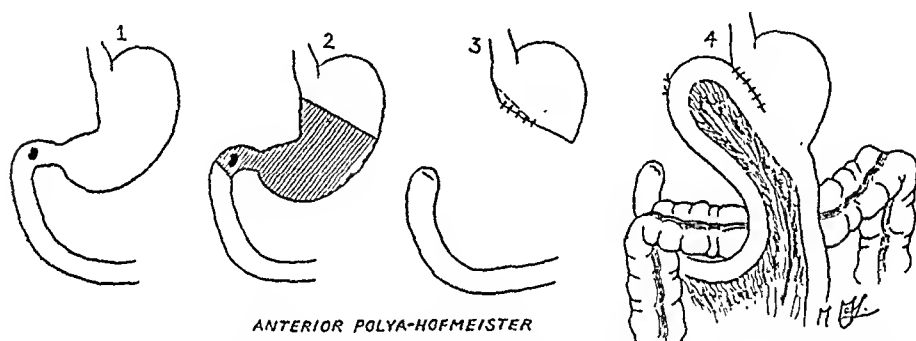
Fig. 3. Partial gastro-duodenal resection, followed by ante-colic Polya-Hofmeister Anastomosis, in a case of chronic duodenal ulcer.

ANTERIOR-POLYA-HOFMEISTER
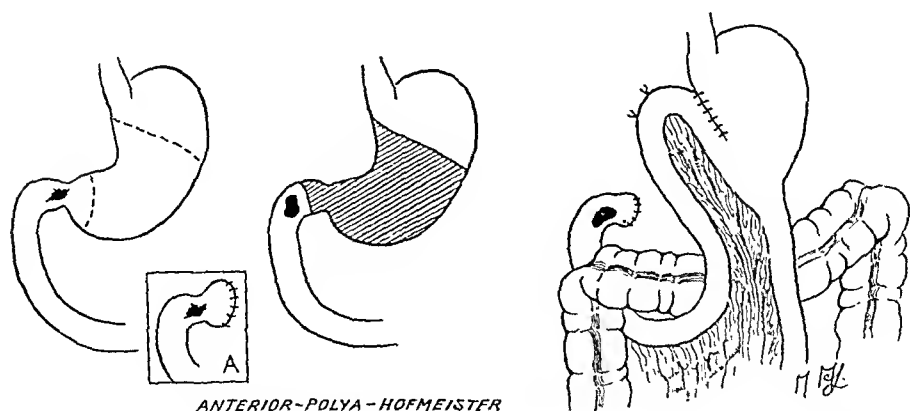
Fig. 4. Gastric resection for duodenal ulcer in which the ulcer is left behind embedded in the pancreas. A=Bancroft's procedure.

Following gastrectomy, these ulcers which are left behind in the duodenum, being excluded and bathed in uncontaminated alkaline juices, rapidly heal and leave few traces of the ravishes they once wrought. But certain duodenal ulcers defy isolation and excision, even when dissection is carried out by crafty, stubborn and skilled hands.

An irremovable duodenal ulcer, then, is one in which the bulb is fused to the pancreas by a large, deeply excavating ulcer and by dense leathery inflammatory adhesions, the crater having burrowed its way into the precincts of the bile and pancreatic ducts, or the involved sclerotic intestine is quite inaccessible.

Most of the deaths which follow in the wake of gastrectomy for duodenal ulcer are due to unnecessary, highly dangerous and protracted dissections of the first part of the duodenum when this portion of the gut is shortened, distorted, and in a state of coalescence with the vital structures which lie posteriorly, or to the surgeon being misguided into believing that the cartilagenous-like scarred zone is a pyloric cancer which must be amputated at all costs. Bancroft's procedure is the one recommended for the irremovable duodenal ulcer. It consists in making a circular incision through the seromuscular coats of the antrum about three finger-breadths above the pyloric sphincter, and dissecting the pyloric mucous membrane free to a point where it is embraced by the muscular ring.

The separation of this cuff of mucous membrane from its seromuscular sheath should be conducted daintily and cautiously, and more especially as the dissection proceeds towards the sphincteric ring where the membrane is soft, oedematous and friable. Any fissuring or tearing of the lining of the pyloric canal itself might be followed by serious consequences—leakage, abscess, peritonitis, duodenal fistula, &c.

A purse-string suture of No. 00 medium chromic catgut, which picks up only the submucosal coat, is passed round the unopened tube of mucous membrane close to the pyloric sphincter, after which the mucous membrane is cut away between hæmostats. The hæmostat near the purse-string suture is removed and the crushed mucous rim is immediately invaginated as the purse-string suture is drawn taut. The tube of mucous membrane should not be ligated and then cut away, as leakage is likely to ensue. One or two other purse-string sutures placed on the exposed pyloric muscle complete the closure. The superfluous seromuscular sheath is trimmed down and its margins drawn together with a sewing-machine stitch, and the stubby end of the pylorus smothered in omentum. No dead spaces should be allowed to remain between the invaginated stump of mucous membrane in the pyloric canal and the freed seromuscular sheath. The operation is completed by performing an ante-colic Polya-Hofmeister subtotal gastrectomy.

Some years ago Finsterer advocated transection of the antrum and distal closure followed by gastric excision for these irremovable ulcers of the duodenum. The late results of the operation are bad : jejunal ulceration is a common sequel, as Ogilvie (1938) and others have shown ;

it leaves behind in the pyloric mucous membrane an agent of evil—a hormone which stimulates the principal glands to pour out pepsin and hydrochloric acid ; while occasionally the stump blows out when the secretions generated in the antral mucous membrane cannot escape through a strictured duodenum. *This operation should, therefore, never be practised.*

On the other hand, Bancroft's procedure leads in time to complete healing of the ulcer, which is constantly bathed in alkaline juices and freed from the irritating, breaking-down products of digestion. The ulcer heals rapidly and in time the first portion of the duodenum becomes free and detached from the subjacent pancreas. In a personal series of 88 cases treated by Bancroft's method there were two deaths—both from peritonitis.

Drainage of the right subhepatic space is carried out as a routine procedure after Bancroft's operation, and also following all those cases in which there is any doubt about the effective closure of the duodenal stump.

The operations practised for the intractable duodenal ulcer are legion and include :

(1) Pyloroplasty.
(2) Gastro-jejunostomy.
(3) Partial or subtotal gastrectomy ; and
(4) Vagotomy, or vagotomy combined with gastro-jejunostomy or partial gastrectomy.

It has been said that every operation on the stomach or duodenum is a success until it is found out. Pyloroplasty has had its day, as may be judged from the statistics from the Mayo Clinic. In 1934, pyloroplasty represented 30 per cent. of all the operations carried out for chronic duodenal ulcer ; in 1946, only one per cent. of the patients with duodenal ulcer were subjected to Judd's or Finney's operation.

It may, however, be indicated when a small anterior-wall duodenal ulcer abuts against the pyloric sphincter, scarring is minimal, obstruction is absent, the size of the lesion is out of all proportion to the symptoms, and the patient is young and highly nervous—a rare combination of events in the surgery of ulcer to-day ; also when after considering all the various factors of the case it is decided that the puny lesion is unworthy of a vagotomy or of a grandiose gastro-duodenal resection.

Gastro-Jejunostomy

As previously stated, the indications for this operation are as follows : (*a*) pyloric stenosis due to a cicatrising duodenal ulcer associated with achlorhydria or hypochlorhydria in patients over the age of 50 ; (*b*) aged and feeble patients with obstructive symptoms or severe pain due to a deeply penetrating ulcer ; (*c*) poor general condition of the patient due to some concomitant disease rendering gastric resection too hazardous.

The *posterior* operation is in almost every respect superior to the anterior. Nevertheless, if the first loop of jejunum is firmly anchored to the under-surface of the mesocolon, or if there are numerous congenital bands or adhesions present in this situation, it may be unwise to dissect them free in order to facilitate the performance of a posterior gastro-jejunostomy. In such cases I am convinced that the anterior operation is preferable.

Again, the posterior operation may be contra-indicated if the mesocolon is unduly laden with fat, or the middle colic artery or its arching branches pursue an anomalous course or are impossible to visualize, if numerous large ramifying blood vessels occupy the mesocolon and no suitable space remains between them through which the stomach or jejunum may be drawn, or where the mesocolon is unduly stunted or is adherent to the stomach bed.

In the posterior operation, if the stomach is large or dilated as the result of obstruction to its outlet, it is best to make the stoma vertical, i.e., from the lesser curvature near the incisura to the lowest point on the greater curvature. If, however, the stomach is small and contracted, a longitudinal stoma, three inches long, placed at or near and parallel with the greater curvature, is preferable. A satisfactory longitudinal stoma should be evenly bisected by an imaginary line dropped from the lesser curve of the stomach ; in other words, it should be situated at the most dependent portion of the stomach.

The stoma when completed should easily admit two fingers. *The portion of proximal jejunum for the anastomosis should be chosen with the greatest care.* If the stomach is ptosed, a long loop (8-10 inches) will be necessary ; but if the organ is of the steerhorn type and lies high up in the epigastrium, a short loop (5-6 inches) will suffice.

The opening in the mesocolon through which the selected fold of stomach is drawn is made to the left of the main branch of the middle colic artery, and the edges of the mesocolon are sutured to the stomach wall *before* the anastomosis is commenced.

Most surgeons follow the practice of Moynihan and the Mayos and prefer to use large guarded clamps and two continuous sutures when carrying out the anastomosis. I usually perform gastro-jejunostomy without the aid of clamps, as spillage does not occur when the gastric contents are aspirated before and during the operation, bleeding can with assurance be controlled by well-placed sutures, and the procedure is relatively atraumatic. The method whereby three continuous sutures are used is the one I usually employ.

Comments on Gastro-Jejunostomy

When performed in properly selected cases, gastro-jejunostomy is an excellent operation yielding a high percentage of splendid results ; but when carried out in middle-aged or young patients with hyper-acidity, it is a damning procedure and is followed by a high incidence of com-

plications including hæmorrhage and stomal ulceration. The subsequent onset of gastro-jejunal ulceration may be expected to occur in fully 30 per cent. of cases in which the patient is 45 years of age or younger and in which the recalcitrant lesion in the duodenum is accompanied by an excess of acid in the stomach.

The results of gastro-jejunostomy are in no way improved by vaso-ligation or by vagotomy. Vaso-ligation and vagotomy have done much to revive the jaded hopes of the gastro-enterostomists. Vaso-ligation is dying the death it so richly deserves, as it is physiologically unsound in theory, whilst in practice it has done nothing to reduce the bugbear of the short-circuiting procedure—gastro-jejunal ulceration.

To add vagotomy to gastro-jejunostomy is to produce a flabby distended atonic stomach which with the greatest difficulty empties its foul decomposing stagnant contents into an unreceptive loop of intestine which is capable of only the minimal amount of peristaltic action. The stomach and proximal coils take weeks or long months to recover from the atony which results and to regain their pristine vigour, while abdominal distension, the belching of cadaveric-smelling gas, and bouts of obdurate diarrhoea are directly attributable to the gastric neurectomy.

The mortality of gastro-jejunostomy for pyloric scar stenosis in elderly patients is two per cent., i.e., about the same as of gastrectomy performed for younger patients with duodenal ulcer in whom the symptoms are unrelenting.

Vagotomy

Vagotomy should not be performed for chronic gastric ulcer. The correct treatment for a patient with a refractory callous gastric ulcer is partial or subtotal gastrectomy.

If a patient with gastric ulcer cannot withstand resection, it is on the whole better to resort to medical therapy than to local excision of the ulcer alone or excision combined with gastro-jejunostomy. Such operations yield results as poor as those of medical treatment. A patient with a gastric ulcer has a cancer in his stomach until it is proved otherwise. The ulcer is innocent if it heals staunchly as shown by gastroscopy and radiology and displays no signs of recurrence after a long period of careful observation. The patient should, however, be suspect for many years.

The recommendation has been made that vagotomy should be used as a therapeutic test for gastric ulcer, the idea being that if the ulcer heals after gastric neurectomy the lesion must be benign. If it fails to heal, it is malignant and should be removed.

" One may also agree that the patient is hardly to be blamed if after one major operation to deal with a gastric ulcer he refuses further surgery when told that his lack of response indicates that his stomach should have been taken out in the first place." (F. D. Moore, Sc.N.A., p. 1078, October, 1947.)

Vagotomy by the trans-thoracic or trans-abdominal route is an interesting and fascinating lesson in human physiology. Surgeons interested in thoracic surgery section the nerves of the chest ; those versed in abdominal or general surgery prefer to expose the vagi through an abdominal incision (Figs. 5, 6 and 7).

The importance of *complete* interruption of all those branches of both vagus nerves which supply the stomach has been stressed by all authorities. In spite of the flattering reception accorded by surgeons throughout the world to this newly-resurrected operation and the pleasing facility with which it can be accomplished with negligible mortality, it is my opinion that this procedure is being carried out at the present time too frequently and too light-heartedly. If the experiment is worth while, and I am convinced it is, then it should be undertaken only by those experienced in gastric surgery and who in addition hold responsible posts where every available facility exists for research work and all that this entails.

It is too early as yet to speak of late results or what place this operation is destined to take in the treatment of chronic duodenal ulcer and gastro-jejunal ulceration.

During the last 18 months I have performed abdominal gastric neurectomy on 42 patients with one operative death. I have already abandoned vagotomy combined with gastro-jejunostomy and also vagotomy plus partial gastrectomy for duodenal ulcer, because with the latter the resection of the gastric nerves appears to be unnecessary following an adequate removal of stomach, whilst in the former I agree with Waltman Walters (Proc. Mayo Clin., 23, 35, 1948) that post-operative complications and morbidity are increased.

At the present time I reserve abdominal gastric neurectomy for the following types of cases :—

(1) Nervous patients under the age of 45 with uncomplicated lesions (no history of massive hæmorrhage and no evidence of obstruction), who have markedly raised acid values in the gastric juice, and in whom *repeated* courses of treatment in hospital have failed to effect a cure ; and

(2) Cases of gastro-jejunal ulcers which have followed in the wake of a well-performed gastro-duodenal resection.

I do not advise trans-thoracic vagotomy for the last-mentioned type of case, as I believe that by the abdominal route large segments of the right and left vagus nerves can be resected after the surgeon has assured himself that the amount of stomach removed is adequate, that no pyloric stump with its baneful mucous lining is left behind, that the stoma is adequate and well placed, that there is no obstruction of the proximal or distal jejunal limbs, and that a gastro-jejuno-colic fistula can be excluded with safety. I would not advise vagotomy for anastomotic ulcer following gastro-jejunostomy because, even if healing of the lesion does eventuate. this is often followed by excessive and progressive scar formation at the site of an all-too-frequently contracted stoma.
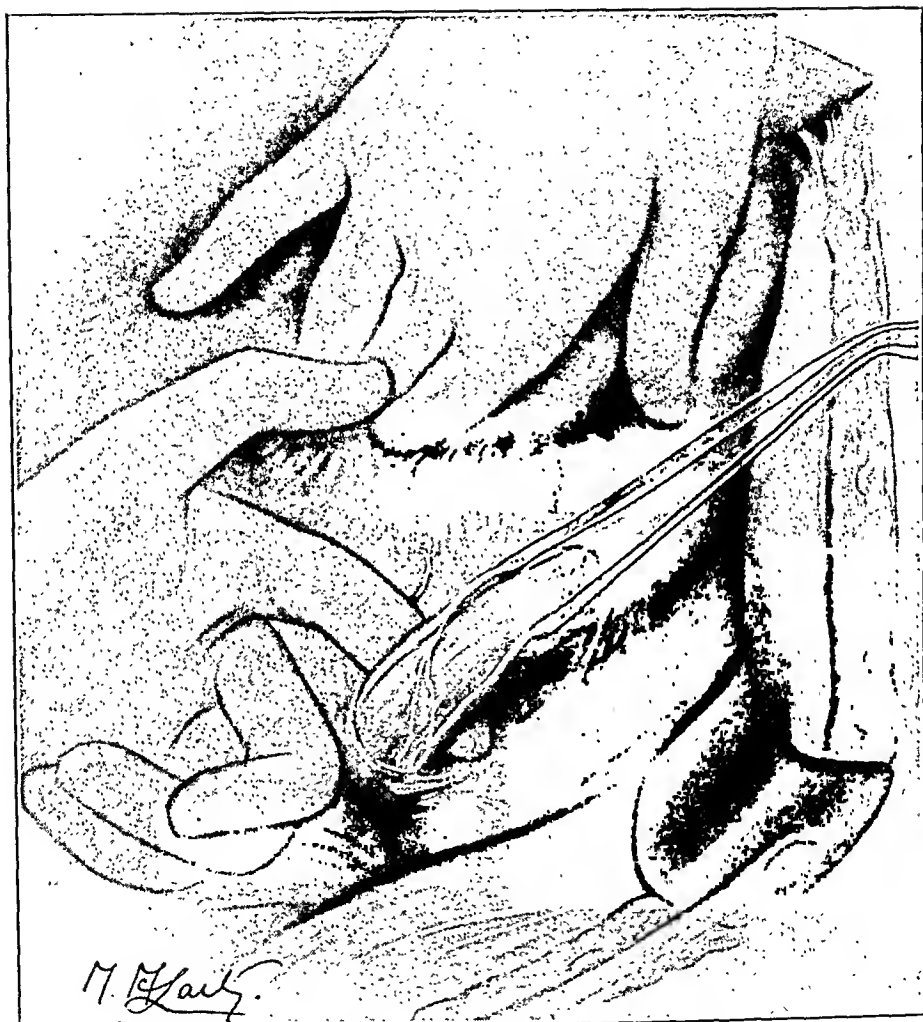
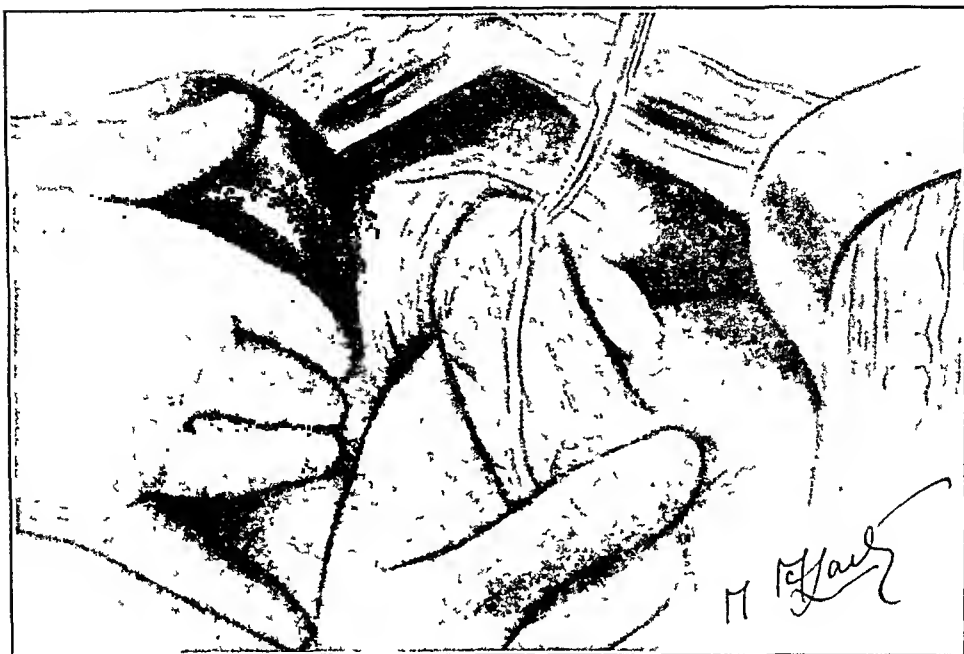Fig. 5. Trans-thoracic vagotomy. The exposure.

Fig. 6
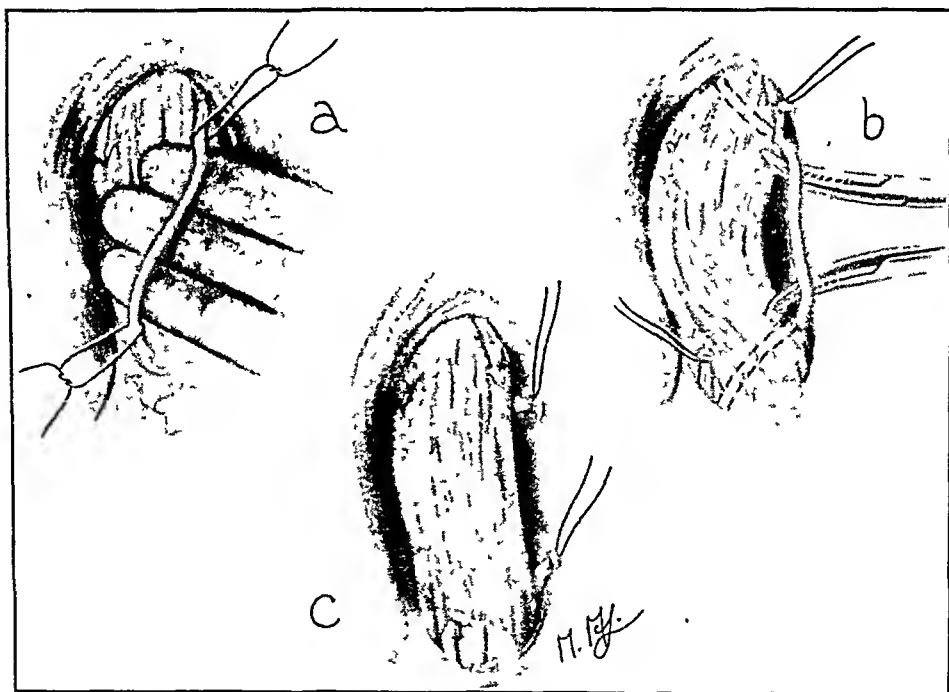Trans-abdominal vagotomy. Isolation of the left (anterior) vagus nerve.

Fig. 7
Trans-abdominal vagotomy. Resection of the vagus nerves of the stomach.

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The healing of the ulcer, combined perhaps with additional spasm of the pylorus, may precipitate a condition of malnutrition, complicated by a low-grade, high, small-gut obstruction.

Some of my patients following vagotomy for uncomplicated but intractable· duodenal ulcer have experienced a number of ill-effects, including dysphagia, diarrhoea, pylorospasm, cardiospasm, the frequent belching of malodorous gases, chronic small-bowel obstruction, and prolonged gastric retention. Two cases with cardiospasm yielded to courses of dilatations with œsophageal bougies. The patients suffering from chronic obstruction responded well to repeated enemata and large doses of trasentin, prostigmin and mechothane. I know of no treatment for chronic gastric retention, particularly for those patients who show no improvement some nine months or so after vagotomy.

The immediate and interim results following vagotomy for an anastomotic ulcer after gastro-duodenal resection are excellent in every respect. Pain is instantly relieved, the ulcer heals with dramatic rapidity, and the longing for food is restored.

There were 37 such cases at the Mayo Clinic (Jan., 1948) with good results in 31, fair results in five, and poor results in one.

(B) GASTRIC ULCER
Indications for Operation

(1) Acute perforation.

(2) Intermittent or continuous hæmorrhage arising from the base of a chronic gastric ulcer which efficient medical measures are in⤳ capable of arresting.

(3) Hour-glass stomach.

(4) The patient is over 50 years of age, has an ulcerating lesion in the stomach and gives a short history of dyspepsia.

(5) Ulcers situated on or about the greater curvature or in the pre-pyloric area.

(6) Ulcers with a diameter of one inch or more.

(7) Chronic ulcer of the stomach associated with anacidity.

(8) Failure of medical treatment—the ulcer stubbornly refuses to heal after four weeks of hospital treatment or breaks down again during the period of observation.

Medical in-patient treatment for a period of one month is warranted if : (1) the patient is young ; (2) there is a short history of indigestion ; and (3) the ulcer is in the vertical part of the lesser curvature and is small. Healing should be demonstrated in one month and confirmed at an examination later in the out-patient department, and then subsequently at intervals varying according to the progress of the case.

It is now generally accepted that complete disappearance of symptoms with a gain in weight when the patient is subjected to medical treatment is no evidence that the ulcer is benign, since a cancerous gastric lesion will, on occasion, respond in this manner when it presents irrefutable X-ray

evidence of its malignancy. The disappearance of the crater as shown on X-ray films, although a favourable sign, does not necessarily imply that the ulcer has healed. The crater may at times become obliterated by exuberant cancer cells which have tipped over into the niche from the malignant margin, or it may be temporarily filled with poorly nourished, œdematous granulation tissue which has made a brave but ephemeral attempt at bridging the gap. It is also by no means exceptional to find on gastroscopy that the ulcer has healed well, but that months later a sinister mound of actively-growing carcinoma cells has arisen from the ill-fated scarred area in the stomach to threaten the life of the patient.

Therefore, as I have previously stated, surgery will be called for in the great majority of patients suffering from chronic gastric ulcer.

Dockerty, of the Mayo Clinic, told me that 18 per cent. of the gastrectomy specimens referred to him and diagnosed microscopically as simple peptic ulcer proved on microscopic investigation to be cancerous.

When we operate for chronic ulcer of the stomach we should do so as for cancer of this organ. I do not know what percentage of gastric ulcers undergo malignant change or what proportion of lesions diagnosed as gastric ulcer are, in fact, ulcerating carcinomata. But I do know that if operation is undertaken only on those cases which prove unresponsive to stringent medical treatment or on neglected cases with sizeable lesions, the microscope will reveal the presence of cancer cells in some 10-20 per cent. of cases.

SUBTOTAL GASTRECTOMY

Most surgeons are now agreed that the ideal operation for chronic gastric ulcer and for most cases of duodenal ulcer is partial or subtotal gastrectomy. The partial operation entails removal of the ulcer together with two-thirds to three-quarters of the stomach and a small portion of the first part of the duodenum. In most subtotal resections I remove from five-sixths to seven-eighths of the stomach—or, at least, I think I do !

The *anterior Polya-Hofmeister operation*, which has been carried out in 98 per cent. of my cases, is the one of choice for the following reasons : (*a*) the anastomosis is readily performed near the accessible greater curvature by construction of a Hofmeister valve ; (*b*) post-operative obstructive symptoms and the sensation of fulness after meals are almost entirely obviated ; (*c*) the technique is simple and the mortality under 3 per cent. ; and (*d*) in the rare event of jejunal ulceration the implicated viscera are approached with ease (Fig. 8).

The *posterior operation* may be called for when the mesentery of the jejunum is short or where for some special reason a partial rather than a subtotal gastric resection is indicated. Obstructive symptoms are decidedly more common with the posterior operation, due, perhaps, partly to the proximal and distal jejunal limbs becoming tethered together in the funnel of retracting mesocolon, and also partly to the difficulty or impossibility of suturing the opening in the mesocolon to the small pouch of stomach which remains after a high resection (Fig. 9).
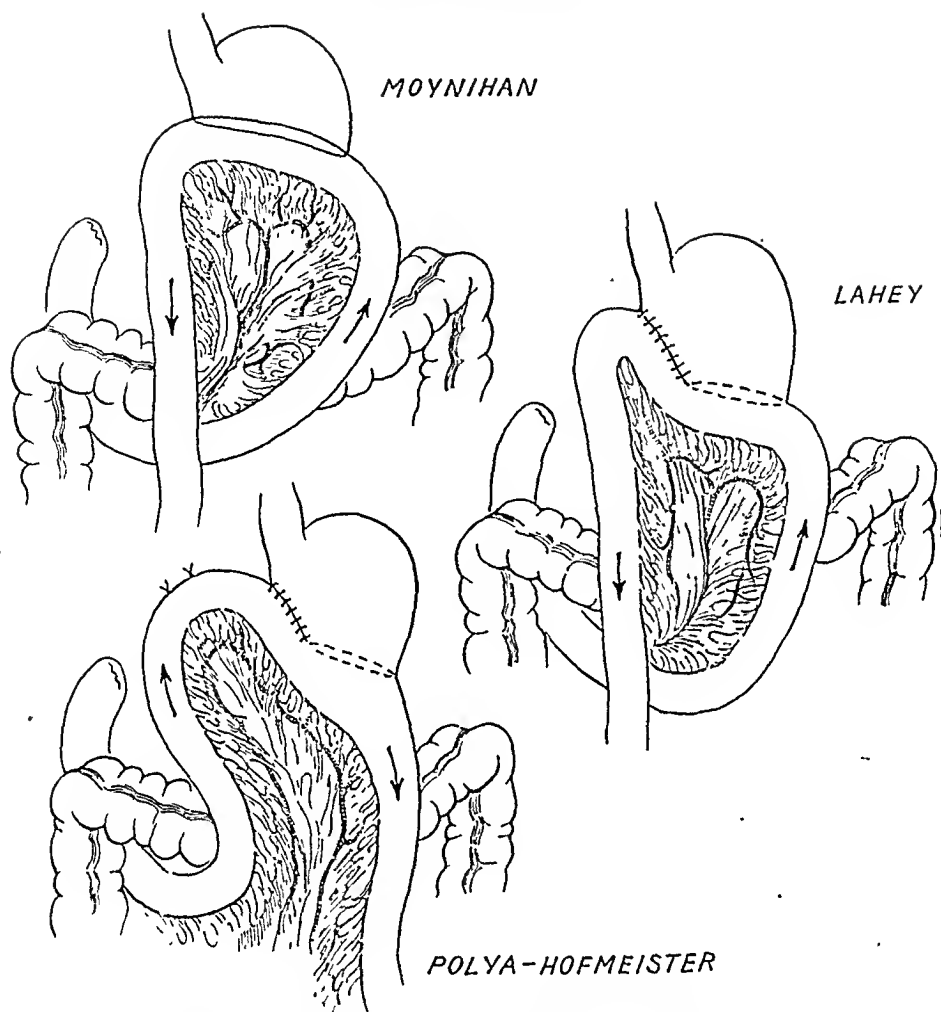
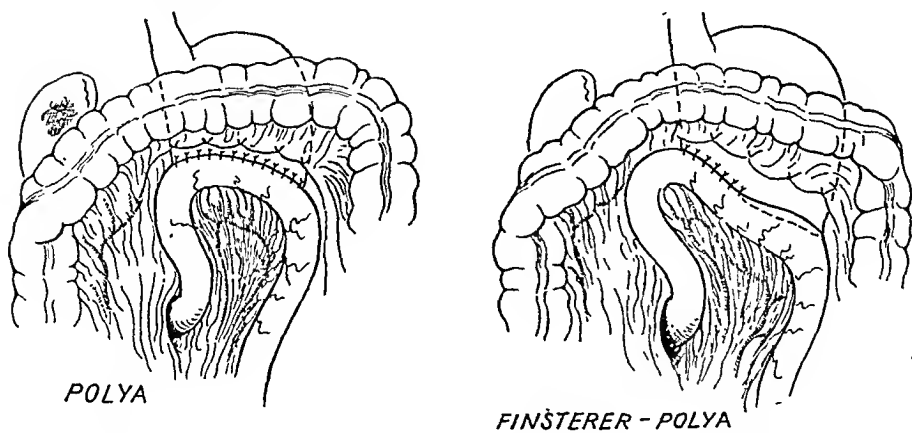Fig. 8. Types of sub-total gastrectomy in common use.

Fig. 9. Posterior types of anastomosis following partial gastrectomy.

Much of the success of the ante-colic type of subtotal gastrectomy depends upon choosing a suitable length of proximal jejunum and upon applying this to the newly reconstructed " lesser curve " of the remaining gastric stump in such a way that the long afferent limb takes a graceful curve from right to left from the flexure to the cardia. The valve and the stoma should be constructed so that all nourishment introduced into the funnel-shaped stomach is deflected into the distal limb of jejunum and into the rich absorptive field beyond, and so that no food can find its way into the duodenum which is rebellious to even a minor degree of distension.

It is claimed that the closed (aseptic) method of gastro-jejunal union reduces the incidence of post-operative peritonitis, infection of the wound and shock, and also the length of time expended on the operation. As, however, the procedure is not truly aseptic, as the measures taken to prevent post-operative hæmorrhage are not uniformly satisfactory, and as the sutures cannot be introduced with the same precision and security as in the open operation, I seldom resort to the closed technique in gastric operations.

The immediate and late results of the anterior Polya-Hofmeister sub-total gastrectomy are most gratifying : the average post-operative stay in hospital is 10-14 days ; the patients on discharge are allowed full diet without restrictions ; they require no medical treatment ; approximately 98 per cent. are restored to full economic efficiency ; the subsequent onset of jejunal ulceration is less than 1 per cent. ; and most patients in the course of time show a definite gain in weight and strength.

Some of the more important complications and unpleasant side-effects of gastrectomy have, as you know, been most ably and comprehensively dealt with recently by Mr. Hedley Visick in his Hunterian Lecture (see page 266).

The operative death-rate is low. In my last 100 consecutive cases there were three fatalities. This is in accord with all recent statistics and is largely due to improved methods of pre- and post-operative treatment; to the liberal use of sulphonamides and penicillin to combat infection, to the " stir-up " treatment to forestall chest complications, to early ambulation, to the excellence of our anæsthetists, to familiarity with the operative procedures, and to many important refinements in techniques which now obtain.

A STUDY OF THE FAILURES AFTER GASTRECTOMY

THE ADVANTAGES OF gastrectomy for peptic ulcer have been well described by several authorities who are the acknowledged experts in gastric work. But it is well to remember that these advantages are only obtained at a cost in operative mortality and post-operative morbidity, and it may be useful to study this other aspect of the picture.

These observations are based on a six-monthly follow-up of a consecutive group of 500 patients whom I treated by gastrectomy between 1936-1947. (Patients treated by emergency operations for acute hæmorrhage and acute perforation are not included.)

Before analysing the results of gastrectomy it is important to understand exactly what operation is under discussion, for the terms radical gastrectomy, partial gastrectomy, and subtotal gastrectomy have no exact anatomical significance, and it is only by watching a surgeon at work that one can understand his interpretation of these operations. Most surgeons state that they remove either " half to two-thirds," or " two-thirds to three-quarters " of the stomach, but I feel that the size of the part which remains is more important than the proportion of stomach which we think we remove.

In practice it is impossible to measure accurately the size of so irregular an organ as the stomach. Therefore, instead of making what is inevitably a vague guess at the proportion of stomach which we intend to remove, we have concentrated on measuring the exact size of the part left in situ.

We did this because we found that, among the first 150 patients treated by " three-quarters gastrectomy," five had developed a recurrent ulcer within 18 months of operation.

Each of these patients was treated by a secondary gastrectomy which produced permanent achlorhydria and permanent relief from pain. It seemed wiser, therefore, to treat all patients by this more radical operation in the first place, if a greater protection against recurrence could be provided.

Fig. 1 indicates the different levels at which most surgeons divide the stomach. The relation of each level to the blood supply should be noted. The line C is the level of half to two-thirds resection, the greater curvature being divided at the level of the junction of the left and right gastro-epiploic arteries. In this operation most of the branches of the left gastro-epiploic arteries are left intact. The line B is the level of two-thirds to three-quarters resection, the greater curvature being divided at the level of the gastro-splenic omentum, involving division of all branches of the left gastro-epiploic artery, but leaving the vasa brevia intact (Fig. 2).

The line A indicates the approximate line of resection which we have adopted as a routine for Measured Radical Gastrectomy.
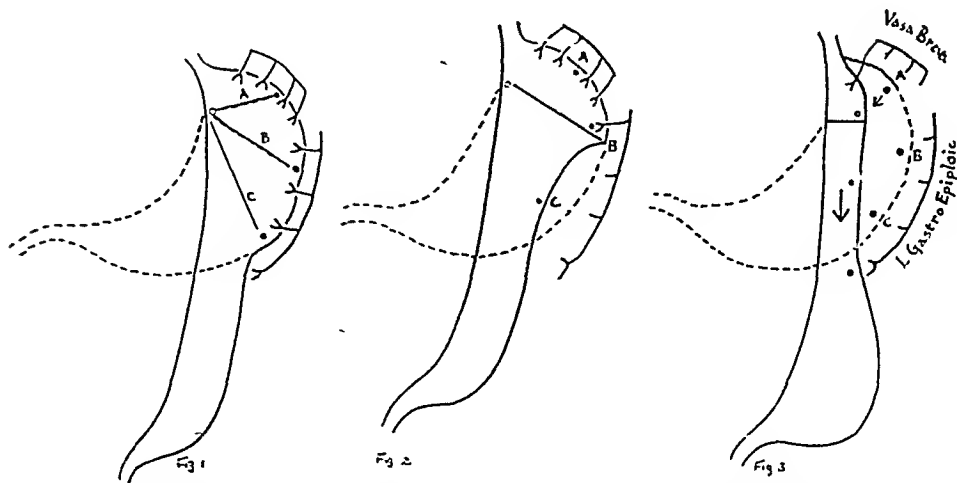

Fig. 1. To show line of section of stomach in relation to blood supply :—A. The Measured Radical Gastrectomy; ·B. The " three-quarters "; and C. The " half to two-thirds."

Fig. 2. The three-quarters gastrectomy. Note the point A remains high under the dome of the diaphragm, anchored against the hilum of the spleen.

Fig. 3. The Measured Radical Gastrectomy. The point A now falls from the spleen and presents in the wound.

In a Measured Radical Gastrectomy, all the vessels of the greater curvature are divided, except the highest one of the vasa brevia (Fig. 3). In cases of secondary or recurrent ulcer, or in patients considered specially liable to recurrent ulcer, all the vasa brevia are divided. The gastric artery is divided close to the pancreas, and the duodenum is cut distal to the ulcer when possible. The line of section of the stomach is made so as to leave a small devascularised remnant 1½ins. along the lesser curvature, and 3ins. along the greater curvature. A 4ins. ante-colic jejunal loop is attached to the lesser curvature, and the anastamosis retracts under the ribs well clear of the left paramedian incision.

As each vessel passing to the greater curvature is divided, the stomach changes shape. It contracts in width, increases in length, and becomes more tubular. Division of the vasa brevia allows 4ins. to 6ins. of additional greater curvature and fundus to be resected without undue tension on the stomach ; and, provided the chest is not deep and barrel-shaped, the anastomosis can be effected outside the abdomen. In most cases the stoma measures 3ins.

This operation makes it possible to remove a surprisingly extensive area of stomach. Division of the vasa brevia mobilises the fundus, and the point A falls away from the spleen and presents in the wound (Fig. 3).

In the three-quarters resection that point remains high under the dome of the diaphragm anchored against the spleen (Fig. 2).

The Measured Radical Gastrectomy differs from a conventional three-quarters gastrectomy in three respects : (1) The area of stomach which remains can be measured and controlled with accuracy ; (2) the gastric remnant is extensively devascularised ; (3) a surprisingly extensive additional area of stomach can be removed.

TABLE I

TO SHOW RECURRENCE RATE IN RELATION TO TIME SINCE OPERATION, AND TO THE EXTENT OF RESECTION

Re-section		Months since operation					
		6	12	18	24	30	36
$\frac{2}{3}$ - $\frac{3}{4}$	No. of patients examined	139	136	135	135	132	132
	No. of fresh recurrences	1	2	2	0	0	0
	Total No. of recurrences	1 (0·7%)	3 (2·2%)	5 (3·7%)	5 (3·7%)	5 (3·7%)	5 (3·7%)
M.R.G.	No. of patients examined	306	252	200	148	90	19
	No. of recurrences ..	0	0	0	0	0	0
	Total No. of patients ..	445	388	335	283	222	151

Table I shows that 18 months after a two-thirds to three-quarters resection, five of the 135 patients available for follow-up had developed a recurrent ulcer. No further recurrence has been discovered although all of this group have now completed 36 months after operation.

No recurrence has been discovered among the 306 patients treated by Measured Radical Gastrectomy.

The danger of recurrence after gastrectomy seems to have been eliminated by adopting the Measured Radical Gastrectomy. It is possible that there is a local factor which has been responsible for this result. We do, however, feel confident that not one of the 433 patients now available for follow-up has symptoms suggestive of recurrence.

There is time to mention only four points in connection with after-treatment which I feel are important in affecting results :

(1) When possible all patients get up and walk for a few minutes the day after operation.

(2) Every patient is given bacon and sausage for breakfast, fried fish for dinner and pork pie for supper while still under the protection of the hospital. It is important that his wife should understand that no further restrictions are needed.

(3) Before he leaves hospital, every patient is given a card of instructions. On no account must it be called a " diet sheet," for to give a man a diet sheet is to make him an invalid for life.

(4) All patients are encouraged to smoke and to drink within reasonable limits, and all emphasis is on their essentially normal and healthy prospects.

Operative Mortality

Ogilvie has stated that " In experienced hands gastrectomy has a mortality not exceeding 2 per cent." In making that statement he has set a standard which remains a goal for us all to aim at.

It should be remembered that this series goes back to 1936 (at which time very few surgeons claimed a mortality of 2 per cent.) and that operative mortality has fallen in recent years as the following figures show :

Cases 1-75 (75 gastrectomies) 9 deaths 12 per cent.

Cases 76-550 (480 gastrectomies) 16 deaths 3.3 per cent.

Last 123 gastrectomies—no death.

Whenever operative mortality is discussed, the number of operations in the series—as well as the proportion of deaths—should be reported, for it is well within the capacity of most surgeons to perform a small (and lucky) series of 100 operations without mortality, but to maintain a high standard of sustained success requires consistently excellent team work.

We have been able to establish at necropsy the cause of each of our 25 deaths, and each of these deaths can be attributed to a failure at some point to maintain the highest standard of vigilance and care.

Pulmonary embolus	5
Pulmonary complications	3
Uræmia	4
Shock	4
Peritonitis	2
Gangrene of colon	1
Hæmatemesis	1
Anæsthetic	1
Carcinoma lung	1
Diarrhoea	1
Asthma	1
Efferent obstruction	1
	25

The causes of our operative deaths may be classified as follows :

(a) Errors in selection for operation.

(b) Errors in preparation for operation.

(c) Errors in connection with the anæsthetic.

(d) Errors in operative technique.

(e) Errors in post-operative management.

It is difficult to fit each of the fatalities into one clear-cut group, for in many cases the patient died from a combination of circumstances. For instance, a death from embolism may be in part due to bad post-operative treatment in giving unnecessary intravenous therapy into a leg vein, and to neglect in detecting the early signs of thrombosis. The deaths from pulmonary complications are in part due to the anæsthetic, and in part to faulty after-treatment.

(a) *Errors in selection for operation.*—Errors of selection of patients for operation accounted for three deaths. In one too great a risk was accepted (a woman aged 59, in very poor general condition, who had four previous upper abdominal operations). In one patient we failed to detect a carcinoma of the lung, and in another we missed atrophic kidneys.

(b) *Errors in preparation for operation.*—Errors in preparation for operation are difficult to assess, and may have contributed to several deaths. It is well to remember that it is possible to over-prepare, as well as under-prepare. Forty-eight hours is sufficient for most patients.

(c) *Errors in connection with the anæsthetic.*—Only one death can be entirely attributed to the anæsthetic—an early case where Pentothal was the only anæsthetic used. The majority of so-called anæsthetic deaths should more properly be attributed to faulty after-treatment. This especially refers to post-operative pulmonary complications.

In this series our preference is for Pentothal—spinal-gas oxygen anæsthesia, and I am indebted to my colleagues, Dr. Haydock and Dr. Porter, for providing uniformly perfect operating conditions.

(d) *Errors in operative technique.*—Errors in operative technique may result in immediate and dramatic complications. At least five patients in this series died from gross technical faults. .

Case 21. General peritonitis. The cause of peritonitis was not discovered post-mortem.

Case 35. Gangrene of colon. If the middle colic artery is damaged, transverse colectomy will save the patient's life.

Case 62. Hæmatemesis. Due to faulty suturing at the gastric suture line. Treatment should be immediate gastrotomy, and oversewing the anastomotic line.

Case 295. Leakage at gastric suture line. Faulty suturing. (No fatal case of leakage at the duodenal stump has occurred in this series.)

Case 404. Efferent loop obstruction. If vomiting persists after operation it is better to explore than to wait until the condition of the patient deteriorates. Entero-anastomosis between the afferent and efferent loops may be indicated.

Poor operative technique may have been a contributory cause in the four deaths from shock and peripheral circulatory failure, and in the three deaths from pulmonary complications.

(e) *Errors in post-operative management.*—Errors in post-operative management have resulted in a considerable number of deaths which

could, and should, have been prevented. In acknowledging this, it is only fair to point out the far greater number of patients who would have died had it not been for the devoted and skilled attention they received, both from nurses and resident staff.

Some of the three deaths from pulmonary complications, the five from embolism, and the four from shock and peripheral circulatory failure might have been prevented if we had been able to detect the early signs of these complications more promptly, and had instituted the correct treatment before their condition became irreversible.

A few examples will show the need for explaining to the nurses and the residents the importance of bedside observation of each patient at 12 and 24 hours after operation.

If I had taken the blood pressure, instead of relying on feeling the pulse of several patients, it might have been possible to detect the onset of delayed shock before the condition became uncontrollable. If I had felt the distended bladder it would have been emptied at 24 hours after operation instead of 36 hours, and uræmia might have been prevented. If I had heard that warning cough, and bubbling respirations, I could have demonstrated to the night nurse the effect of instituting the " shake-up " treatment as soon as the first signs of obstruction were noticed. If I had realised the danger of post-operative diarrhoea, I would have taken more stringent measures which might have prevented a fatal issue. The patient who died of asthma would have had Adrenalin ; unfortunately, he had none.

In a review extending over 12 years, it is inevitable that one can recollect many preventible mistakes. Each has led to tragedy, but from each we must learn how to prevent such tragedies occurring again in the future.

I have noticed that especially important patients, or patients about whom we are particularly anxious, very rarely die. The majority of deaths have been unexpected, and occurred in good risk patients after an easy operation. This suggests that, for the moment, we relaxed our standard of observation and care.

I believe that the majority of operative deaths are preventible—that, by maintaining the level of team work, it should be possible to keep the mortality in the region of 1-2 per cent.

The secret of success is *team work*, and the position was modestly summed up by one of my house surgeons who remarked : " Provided that the chief is in moderately good operating form, I can keep his patients alive so long as sister is not away for the week-end."

Operative mortality is also related to certain other factors. The following Tables refer to the later series of cases—(16 deaths in 480 gastrectomies, making a total incidence of 3·3 per cent. mortality) :

TABLE A

If the history extends over five years, operative mortality is doubled.

A.—Operative Mortality in Relation to Length of History

	Over 5 years	Under 5 years
No. of cases	353	117
Deaths .. .. ′	14 (3·9%)	2 (1·7%)

TABLE B

Mortality in those over 40 years of age is over eight times that in the under-40 group.

B.—Operative Mortality in Relation to Age at Operation

	Under 40	40-49	50 and over
No. of cases	166	181	123
Deaths	1 (0·6%)	8 (4·4%)	7 (5·6%)

TABLE C

Mortality when the ulcer penetrates all coats of the stomach or duodenum is twice that of simple ulcer.

C.—Operative Mortality in Relation to Depth of Penetration

	Simple ulcer	Chronic penetration
No. of cases	316	154
Deaths	8 (2·5%)	8 (5·2%)

TABLE D

Mortality of gastric ulcer is almost twice that of duodenal ulcer.   Only 1 in 30 patients with secondary ulcer died.   (This group includes six recurrent ulcers following gastrectomy, and 24 secondary ulcers associated with previous gastro-enterostomy.)

D.—Operative Mortality in Relation to Type of Ulcer.

	D.U.	G.U.	S.U.
No. of cases	375	106	30
Deaths .. .. .. ∴	·10 (2·7%)	5 (4·7%)	1 (3·3%)

GASTRIC FOLLOW-UP CLINIC

Surgical treatment of a patient with peptic ulcer does not just mean operation, and then abandoning the patient to his own devices. We have found that the incidence of failures is markedly decreased if we maintain close contact with all patients during the critical months which follow discharge from hospital. This can only be done through an organised follow-up clinic.

Such a clinic is an essential department of any modern hospital. It is no good waiting for patients to come on their own to report their complications, and an out-patient clinic in which patients are told to " come and see the doctor in six months " does not constitute a follow-up clinic.

There should be some organization which ensures that every patient is seen by appointment at monthly intervals for the first six months, and later at six-monthly intervals. Those who fail to keep their appointments are written to, and, if this fails, they are visited in their own homes. If a longer interval than six months is left so many will have changed their address, and we may lose sight of them. In this series we have failed to trace only three patients out of the 500. This low incidence can only be maintained by very keen secretarial and social service work.

The clinic is attended by a physician, the radiologist and the surgeon, and it is important that the latter should attend personally, and not delegate this duty to an assistant. The more personal the atmosphere, the more likely are patients to attend regularly, and it is only by following cases thus that one learns the many factors that are involved in the success or failure of surgical treatment.

The almoner and the social service worker also attend each clinic.

At each visit patients are graded according to their gastric symptoms, but the grading should not be done by the surgeon alone, because it is impossible to avoid the bias of enthusiasm. Sometimes patients fail to disclose their symptoms for fear of disappointing their surgeon.

Grade I : No symptoms.
Grade II : Mild symptoms relieved by care.
Grade IIIs : Mild symptoms not relieved by care, but satisfactory.
Grade IIIu : Mild symptoms not relieved by care. Unsatisfactory.
Grade IV : Not improved.

(Grades IIIu and IV are considered failures.)

From the records of this clinic we can produce statistics which are always up to date, and by attending its sessions we can learn how to recognize the type of patient who will not respond to operative treatment.

One great advantage is that we can detect and treat failures early, study the causes of failure, and take steps to ensure that such failures do not occur in the future.

The clinic is a means of encouraging close co-operation with local general practitioners. It forms a link between hospital and home to ensure that social service work begun in hospital shall be continued in the home without interruption.

GENERAL RESULTS

Only 433 of the original 500 patients were available for follow-up in December, 1947. The remainder are accounted for as follows :

Total number of patients		500
Operative deaths 25		
Late deaths 2		
Intercurrent deaths.. 12		
Lost sight of 3		
Less than six months since operation 25	67	
Available for follow-up	433	
	500	

TABLE 2

THE SIX MONTHS'—TWELVE YEARS' RESULTS

Detailed grading of 433 patients available for follow-up, December, 1947 :

Grade	Incidence	
	Per cent.	
I	62·1	(No symptoms.)
II	16·5	(Mild symptoms easily controlled.)
IIIs	16·4	(Mild symptoms not controlled. Satisfactory.)
IIIu	2·8 ⎱ 5·0	(Mild· symptoms not controlled. Unsatisfactory.)
IV	2·2 ⎰	(Not improved.)

Table 2 may be termed the " six months' to 12 years' results." It shows that 5 per cent. of the patients available for follow-up in December, 1947, were failures.

It corresponds with the usual *questionnaire* call-up, but since we have kept in constant contact with all patients, we have lost sight of only three, and we were able to verify the cause of all intercurrent deaths.

There are three objections to this form of presentation :

(1) It fails to explain the proportion of recent cases included in the series.

(2) It can give no indication of improvement or deterioration of results according to the time that has elapsed since operation, and it will only be accurate if very little change in grading has occurred since operation.

(3) It only reports the proportion of patients who were failures at the time of their last examination in 1947, and gives no indication of the number of patients who may have been failures at any earlier period, and who may have responded to treatment.

Some of these points can be explained by reporting all results at six-monthly intervals.

Fig. 4 shows the grading of all patients at each six-monthly examination. (The " six months' to 12 years' " table is entered in the last column for comparison.)

The total number of patients seen at each six-monthly examination is shown in the top line. The 12 intercurrent deaths account for the fact that 433 cases were available in December, 1947, whereas 445 were seen six months after operation.

Fig. 4 makes it clear that only 73 patients have been operated on more than 42 months. It is, therefore, only of value as a report of recent results. The number of patients followed, as well as the time they are followed, should always be shown.

This graph indicates that very little change has occurred within the period of these observations. The " six months' to 12 years' " table shown in the last column for comparison can therefore be accepted as a rough indication of results at any period, but it gives too favourable an impression of early results.
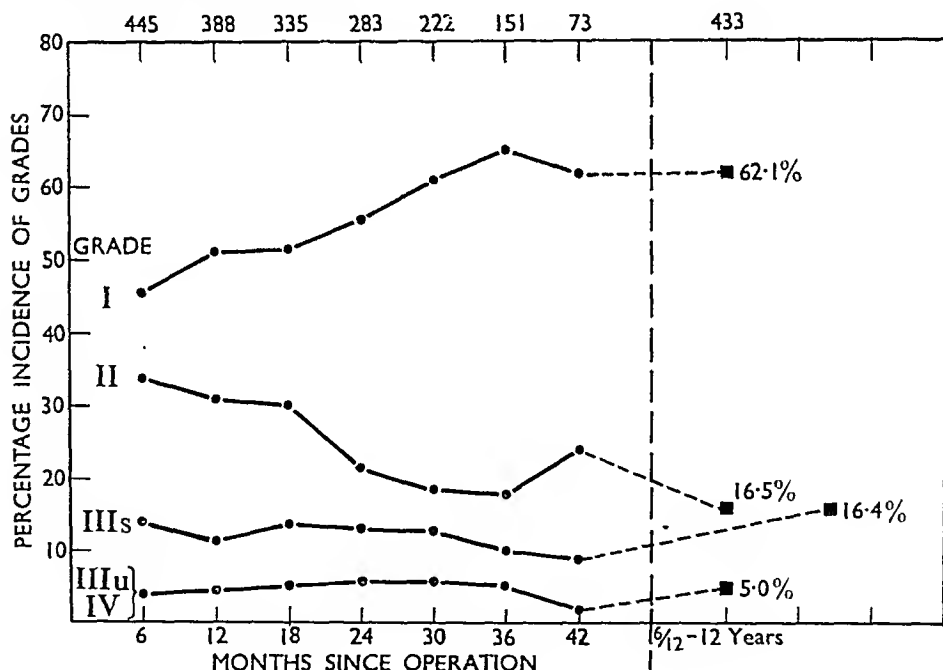
Fig. 4

Such change as has occurred is a gradual shift towards Grade I, the symptom-free group, at the expense of Grades II and IIIs. There is improvement and not deterioration of results with the passage of time, for the proportion of symptom-free patients has increased from 47 per cent. at 6 months to 63 per cent. at 42 months.

This method of presentation fails to indicate if there has been any improvement in the results of more recent operations compared with those operated on earlier in the series. Also, although the proportion

of failures shown at each six months' review remains constant, it does not follow that the same individual patients remain failures. These points are dealt with by reporting the incidence of failures among separate groups of 100 patients (Table 3).

The first column in Table 3 shows the number of failures in each group at six months after operation, and indicates that fewer failures have occurred in the more recent series. This is in part due to a more rigorous selection of patients for operation, and in part to a more intense follow-up during the first six months after operation. In the earlier series we accepted a proportion of patients with a marked neurotic overlay. This experiment was a failure, and has left us with too numerous a legacy of failures.

At 12 months after operation the number of failures in the first group of 100 patients has increased to seven, three new failures (+3), and no responses to treatment (−0). By the 42nd month only two patients remain failures.

TABLE 3

GRADING AT SIX-MONTH SURVEYS OF GROUPS OF 100 PATIENTS

Cases No.	6 months	12 months	18 months	24 months	30 months	36 months	42 months
1-100	4	+3 7 −0	+1 6 −2	+1 3 −4	+0 3 −0	+0 3 −0	+2 2 −3
101-200	4	+4 7 −1	+1 5 −3	+3 5 −3	+1 4 −2	+2 6 −0	
201-300	7	+0 6 −1	+1 5 −2	+1 5 −1			
301-400	1	+1 2 −0					
401-500	2						

Each group refers to 100 original cases, not to 100 patients available for follow-up at each survey.

Cases No.	Total ever failures	Total responded to treatment	Existing failures
1-100	11	9	2
101-200	15	9	6
201-300	9	4	5
301-400	2	0	2
401-500	2	0	2
	39	22	17

Results are not static, and at each six months' review a few new failures have occurred, and an almost equal number of previous failures have responded to treatment.

Each square can only be completed when the whole of the 100 patients in the group have passed the six months' period. This time lag accounts for the fact that only 17 out of the existing 21 failures are shown.

The actual figures recorded in December, 1947, show that 43 patients (8·4 per cent. of the original 500) have at some time been graded a failure. Of these 22 have responded to treatment, and 21 (4·2 per cent.) remain failures at their last examination in 1947.

As a result of the continuous follow-up we have two groups of failures for study—the temporary past failures, and the existing failures, some of whom are permanent failures, and some of whom will prove to be temporary failures.

It is now possible to verify that, although the incidence of failures at any time after operation has remained constant at 5 per cent., the individual patients constituting this group are constantly changing. Half are permanent failures, and half are temporary failures.

Permanent failures are identified early, often while still in the ward immediately after operation. They remain failures as long as they are followed up.

Temporary failures can occur at any time after operation, and they can be recruited from any one of the three satisfactory grades. (Case No. 1 has recently been graded a temporary failure, 11 years after operation, but she responded to treatment.) The duration of temporary failure is seldom more than 12 months (15 lasted six months, five lasted 12 months, and only two lasted 18 months). There has so far been no tendency to see-saw in and out of the failure group. Once they respond to treatment they have not failed again—but this may occur when they have been followed for a longer period.

The total incidence of permanent failures has remained constant, and has been determined by the sixth month (2·5 per cent.).

The total incidence of temporary failures increases with the length of follow-up, but the proportion of temporary failures has remained about 2·5 per cent. at each six-monthly review, irrespective of the time elapsed since operation.

	D.U.	G.U.	S.U.
Grade I, II, IIIs	95.0%	98·1%	28
Grade IIIu, IV	5·0%	1·9%	3

Further study of available statistics confirms that patients with gastric ulcer are more likely to prove satisfactory than patients with duodenal ulcer.

SYMPTOMS CAUSING FAILURE

The incidence of symptoms will be found to vary according to the diligence with which they are searched for. We never accept a patient's statement that he feels " champion " as meaning that he is symptom free. In every case we ask direct questions, even at the risk of suggesting troubles of which patients are unaware.

The majority of complaints fall into four well-defined groups :
Pain.
Fullness.
Vomiting.
Weakness, sweating, dizziness, etc.

Less commonly a patient will be disturbed by anorexia, loss of weight, or aversion to certain foods.

The majority of failures complain of several groups of symptoms ; occasionally only one group of symptoms will persist.

These are new symptoms, caused by the gastrectomy. The grade to which a patient is thereby relegated is determined partly by the frequency and severity of the symptoms, and partly by their effect on the patient.

Pain.—Pain is the least common and most disappointing complaint. It occurred at some time after operation in 10 per cent. of the whole series, and in 80 per cent. of the failures.

Severe pain always suggests recurrent ulcer. Usually it is indefinite, bears no relation to food or to the position of the stomach when screened. Relief usually follows rest and limitation of the size of the meal.

The majority of patients admit that their complaint is of discomfort rather than pain. Less than two per cent. state that the intensity of pain is as bad as it was before operation.

Acute Pseudo Perforation.—An interesting group of six patients who have had a previous gastrectomy were admitted to hospital with a diagnosis of acute perforation. In each case there was a sudden onset of severe abdominal pain associated with abdominal rigidity. The appearance of the first case left no doubt in my mind that immediate operation was indicated—yet nothing abnormal was found when I explored him. No adhesions, no free fluid, no sign of peritoneal irritation. The next five cases were successfully treated by morphia, and all recovered within 12 hours without complications.

Fullness.—Fullness is the most common symptom and has occurred in 70 per cent. of all patients at some time after operation. Sixty-six per cent. of existing failures still complain of this symptom.

It usually responds to limitation of the size of meals, and rest. Most patients discover their limitations within six months, but a few seem unable to resist large meals at week-ends, and continue to suffer discomfort for two to three years.

X-Ray.—Screening under X-ray confirms that fullness is due to jejunal intolerance and not to distension of the gastric remnant.

Vomiting.—Twenty-one per cent. of all patients complain of vomiting; 31 per cent. of the 43 failures suffered from this symptom. Vomiting of food is rare. Most patients state that the vomit is yellow or green, and has a very bitter taste. In quantity it varies from a teaspoonful which is swallowed immediately, to several tumblersful. In some cases it occurs half-an-hour after every meal, and in others at longer intervals. The longer the interval since operation, the longer the intervals between attacks, until finally they cease altogether, but they may persist for two to three years.

Limitation of the size or quality of the meal has no effect, and it is one of the most distressing and intractable of all post-operative symptoms.

Occasionally the vomiting of large quantities of bile occurs at intervals of two to three months. Such patients feel a sense of gradually increasing epigastric discomfort which is finally relieved by vomiting—which is usually self-induced.

Frequent vomiting of small amounts of bile may be due to the sudden emptying of the gall bladder after meals, but the vomiting of large quantities of foul-smelling bile-stained fluid suggests some partial obstruction at the afferent stoma.

Weakness Syndrome—often called " Dumping " Syndrome which is a singularly unfortunate term since all symptoms are associated with dumping, i.e., rapid emptying.

A group of symptoms variously interpreted by the patient as causing weakness, faintness, sleepiness, tiredness, palpitation, dizziness and sweating. This syndrome has occurred in 16 per cent. of all patients, and in three of the 43 who have at some time been graded a failure.

Of those who develop these symptoms, 85 per cent. occur within six months of operation (15 per cent. within one month), and 15 per cent. for the first time more than six months after operation.

It is true that the blood sugar curve in these patients usually reaches a higher line than in symptom-free patients, but the symptoms cannot be caused by the subsequent hypoglycæmic fall since they occur immediately after a meal, while the blood sugar is rising to its height.

Most patients state that they feel compelled to rest, but that the sensation wears off after 10 to 20 minutes.

We have found that most of these patients report that symptoms disappear spontaneously within one year. The longest we have recorded is three years, the shortest one month. Occasionally it is the only symptom complained of; more usually it is associated with other symptoms of fullness, bile, vomiting, &c.

The degree of disability caused is slight, provided that the patient is able to rest after the meal—no patient has been incapacitated by these symptoms.

Breakfast and tea rarely cause weakness. It is usually after the main meal of the day, either dinner or supper.

We have tried to find out if a heavy protein meal or a heavy carbo-hydrate meal causes more distress, but reports of patients vary to such an extent that we have failed to settle the point.

- Women, and those under 40 years of age (male or female), are rarely affected.

INVESTIGATION OF FAILURES

As soon as the patient is graded a failure in the follow-up clinic, we make arrangements for him to be admitted to hospital for investigation and observation. Border-line cases often respond to reassurance and explanation, but more severe cases require further study by fractional test meal, gastroscopy, and X-ray screening.

Before the patient is admitted to hospital, I visit him in his own home on a Sunday afternoon. By talking with him, and with his wife, I gain some idea of his temperament and personality, and of the social and economic problems he is up against.

While in hospital all failures are given a fractional test meal. Although this examination is no help in diagnosis, it is useful for prognosis, for a patient with achlorhydria is unlikely to develop a recurrent ulcer.

Besides investigating the psycho-somatic aspect of patients with unsatisfactory results, I make a point of being present when each patient is screened. Even if no filling defect is discovered screening has an important psychological effect, for one can assure the patient that one has seen his stomach and that there is no recurrent ulcer.

First we observed the gastric remnant in the symptom-free patient. We found that in many cases the meal passes straight through the stomach (Fig. 5. 1). Sometimes there is a hold-up at the efferent stoma lasting for a few seconds to two-three minutes, after which the meal leaves the stomach intermittently (Fig. 5. 2). Occasionally a little meal
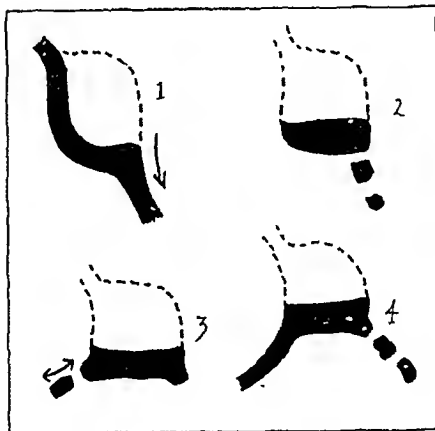

Fig. 5

enters the afferent loop and is immediately extruded by a violent wave of peristalsis (Fig. 5. 3). Very rarely the meal enters the afferent loop freely and outlines the whole of the remaining duodenum (Fig. 5. 4). Provided there is no obstruction at the efferent stoma, the patient is entirely unaware that the meal has entered the afferent loop.

In most cases the gastric remnant is empty within $1\frac{1}{2}$ hours.

A Hoffmeister valve is constructed to ensure a unidirectional flow of food, and to attempt to control the emptying time of the stomach. In this series no valve has been made, and the behaviour of the gastric remnant as observed by X-ray screening cannot be distinguished from that seen after a valve has been made. Nature makes her own valve, for on several occasions at gastroscopy I have noticed a tight spasm in the region of the afferent loop which relaxes at times to allow bile to enter the stomach. The appearance of the efferent stoma shows a striking contrast. It is relaxed, and funnel-shaped.

As for controlling the emptying time, unless the end of the stomach is narrowed to the point of producing actual organic obstruction, the Hoffmeister valve technique cannot affect the emptying time of the stomach because that is controlled by the diameter of the narrowest part of the food tube into which it enters, i.e., the jejunum.

The Hoffmeister valve, therefore, plays no essential part in affecting the direction of the flow of food, or in controlling the emptying time of the stomach, after a Measured Radical Gastrectomy.

We then observed the behaviour of the gastric remnant in every patient graded a failure, in many of whom we made repeated examinations.

We found that pain similar in type to the pain of the original ulcer was associated with a recurrent ulcer on five occasions.

One characteristic of these ulcers has been the large size of the ulcer crater, which penetrates deeply into the surrounding viscera. If the crater is not visible there may be a hold-up due to spasm of the efferent stoma, local tenderness, and deformity of the jejunal outline.

Not every patient who complains of pain has a recurrent ulcer. Often the pain is indefinite, it has no relation to meals, and it may have no relation to the position of the stomach.

In those patients with marked neurotic overlay, pain may be localised to the duodenum (which has been removed), to the region of the aorta, or to the ribs. Tenderness may be present in any area remote from the stomach and jejunum. If, after repeated examinations, especially during bouts of pain, the appearance of the stomach remains within normal limits, a functional basis for the pain may be presumed, provided that achlorhydria is present.

Radiology helps us to sift the organic from the functional. At times it gives evidence of an organic basis which is overshadowed by the functional. If the case is entirely functional, screening is most helpful in treatment for we can reassure the patient that we have actually seen his stomach and that there is no sign of recurrent ulcer.

Patients who complain of vomiting bile show no demonstrable abnormality. The majority empty rapidly, which explains why food is so rarely vomited.

We have often noticed that the stomach is almost empty at the very moment a patient complains of fullness. This symptom must then be due to jejunal intolerance and overloading.

We have not found that symptoms of weakness, sweating and tiredness, etc., are associated with any constant abnormality of behaviour seen by screening.

Occasionally there is evidence of efferent loop obstruction. Such patients complain of discomfort after food, fullness and vomiting of bile, or less commonly, of food.

Appearances in such patients are characteristic. There is marked delayed emptying associated with epigastric distress. The meal can be seen to be whirling about, see-sawing back and forth. Finally a blob of meal seems to heave itself up and spills over a raised loop of jejunum which resembles a question mark—which makes a convenient name for the condition (Fig. 6. 1).

Fig. 6

In five patients symptoms were so severe that I explored them. In each case the remains of the greater curvature were pulled up against the hilum of the spleen, causing the jejunum to be drawn up with it and kinked into the question mark deformity.

Associated with the traction upwards there was on three occasions a stoma of larger calibre than usual. The jejunum opposite the stomach had sagged as if it could not support the weight of the stomach contents, and the writhing movements of this bulged jejunum were clearly evident on the screen, causing a further kinking of the efferent stoma (Fig. 6. 2 and 3). The size of the stoma is, therefore, of great importance.

Provided it is not more than 3ins. long this sagging has not been observed.

In the three-quarters type of gastrectomy, the end of the stomach measures more than 3ins. in diameter in many patients. Therefore, in such cases the Hoffmeister valve technique does serve a useful purpose in narrowing the end of the stomach, and so preventing the sagging of the jejunum with its resultant obstruction at the efferent stoma.

Patients with unsatisfactory results can be divided into three groups by means of radiological examination :—

(1) Patients with recurrent ulcer.

(2) Patients with mechanical obstruction at the efferent loop.

(3) Patients with normally emptying gastric remnant.

TREATMENT

The treatment of each failure is first to deal with any demonstrable organic cause, and at the same time to give intensive psycho-somatic treatment in order to deal with any social, economic or emotional difficulties which might be responsible for symptoms.

Under this combined treatment it is not long before it becomes clear to which group of failures each patient belongs.

Temporary Failures

Some recover spontaneously for no apparent reason. Others respond to explanation and reassurance, and others to some definite action which we have been able to take to help them.

A man, newly married, was living in great discomfort with his in-laws, sharing a house with three other families all using a common gas cooker. His symptoms disappeared when we were able to obtain a " prefab " for him.

We arranged for a man, whose pain and vomiting recurred as soon as he became unemployed, to enter a government training camp, where he has remained well in the security of regular employment.

A woman of 30 was lonely and depressed after the loss of her husband. Pain, vomiting and fullness accentuated her misery. Radiant happiness followed her remarriage to an Australian, and she now writes that all her symptoms have disappeared.

These examples indicate the psycho-somatic origin of symptoms, and the need for assessment of every possible causative factor.

In temperament these patients are midway between the satisfactory results and the permanent failures. They are easily suggestible, and, for the moment, have lost heart. They are not neurotic—they just

could not " take it " when the difficulties of life seemed unbearable. Such patients form the bulk of temporary failures.

Permanent Failures

Permanent failures are just one step nearer to incurable mental and moral breakdown. At one extreme we have the drunkard, the neurasthenic and the malingerer, and at the other extreme we have the patient who rather enjoys his misery and is loath to forgo the advantages of invalidism. We have examples of men who hate their wives, of wives who love the lodger and nag their husbands, and men who are passed over for promotion and harbour a sense of social injustice. Most of these present an insoluble problem, and, in spite of the efforts of psychologists and social workers they persist in their maladjustment to life. They are not so much failures of gastrectomy as failures of selection for gastrectomy. They remain the hard core of incurables, and will probably remain so whatever treatment is given to them.

Final Summary of Results

We are now in a position to produce the Balance Sheet.

A reasonable number of patients (500), have been followed over a period varying from six months to 12 years, and assessed by a physician and a radiologist. Each patient was treated by a Measured Radical Gastrectomy, leaving a devascularised remnant one and a half by three inches in length.

This operation, together with intensive follow-up, has given permanent protection against recurrent ulcer (within the limits of this follow-up). It has also given relief from pain, provided that the mental outlook of the patient is normal.

Of those patients who are available for follow-up, 79 per cent. have excellent results, and a further 16 per cent. are much improved, making 95 per cent. satisfactory.

The cost of this operation has been 3·3 per cent. operative mortality for the last 480 operations, and a failure rate of 5 per cent., half of whom are permanent failures and half temporary failures.

I should like to take this opportunity to acknowledge the immense help I have received from my medical colleague, Dr. Cameron, and from our radiologist, Dr. Pulvertaft, whose diagnosis has proved correct in 93 per cent. of these cases.

11. SIR JONATHAN. HUTCHINSON AND OTHER MEMBERS OF THE COURT OF EXAMINERS

A RECENT ACQUISITION of the College is a picture which will awaken varying memories in the minds of most readers of the *Annals*. It depicts a meeting of the Court of Examiners in the Council Room of the College during the Viva Voce in Surgical Pathology in the Final Examination for the Fellowship.

The picture was presented to the College by the three surviving members of Jonathan Hutchinson's family of ten :—Dr. Roger Hutchinson, Mr. Herbert Hutchinson (the author of " The Life and Letters of Jonathan Hutchinson ") and the youngest daughter, all of them now about 80 years old. Before the war Dr. C. Kay Sharp of Leeds had seen the picture in the Hutchinson Museum at Selby, in Yorkshire, which was Jonathan Hutchinson's birthplace, and informed the President of the fact. Learning that the picture was eagerly desired by the College, Dr. Hutchinson and his brother and sister took up the matter with the Trustees of the Hutchinson Museum at Haslemere to which the picture had been transferred when the Selby Museum came to an end. With the consent of the Trustees, the family gladly offered the picture to the College and Dr. Hutchinson wrote that they would like the Council to know " How very pleased we are that the great man's likeness should find a resting place in the College that he loved." Is it any wonder that the gift was warmly welcomed by the Council, for Sir Jonathan Hutchinson had been President of the College and has an honoured place in the history of British Surgery. He was one of the last of the " Admirable Crichtons " of the profession, and, as Osler said : " He was a man of truly Hunterian mind, and the only great generalized specialist which the profession has produced. His works are a storehouse upon which the surgeon, the physician, the neurologist, the dermatologist and other specialists freely draw. When anything turns up which is anomalous or peculiar, anything upon which the textbooks are silent and the systems and cyclopædias are dumb, I tell my students to turn to the volumes of ' Hutchinson's Archives of Surgery'."

Dr. Roger Hutchinson writes : " The picture represents Jonathan Hutchinson and ' old Johnny Wood ' examining an unfortunate student. It reminds me painfully of the terrors of that examination." The picture was painted by Henry Jermyn Brooks in 1894. It does not represent Members of the Court at an actual examination, but rather a selected group of colleagues, for Jonathan Hutchinson retired from the Court in 1887, and John Wood, the other examiner at the centre table, retired from the Court in 1889 and died in 1891.

Efforts have been made to identify the other examiners portrayed and, in the general opinion of those who have compared the portraits with others, the two examiners at the right-hand table, are F. Le Gros Clark (Court 1881-86) and John Marshall (Court 1873-81, died 1891) ; and those at the left-hand table, Sir William MacCormac (Court 1887-97) and Edward Lund (Court 1883-87).

WILLIAM MACCORMAC   JOHN WOOD   JONATHAN HUTCHINSON   F LE GROS CLARK
EDWARD LUND   JOHN MARSHALL

The picture hangs in the Refectory at the College, where post-graduate students can get a preview of the setting for the Viva Voce Examination. It has been amusing to get visitors and others to try to identify the candidates. It has been suggested that the victim on the right might be Alfred Fripp, that on the left Holburt Waring, Warren Low or Christopher Addison (now Viscount Addison, K.G.,) and that at the centre table F. F. Burghard or William Lister. These were all contemporary candidates in the period covered by the Examiners. *Suggestions are invited.*

<div style="text-align: right">W-J.</div>

SAYINGS OF THE GREAT

" Knowledge and timber shouldn't be much used till they are seasoned."—*Oliver Wendell Holmes.*

" It is easy to play the game from the grand stand."—*Harvey Cushing* (Contributed by Professor Lambert Rogers, V.R.D., F.R.C.S.)

" Teaching means the imparting of knowledge, and for that we are dependent on our teachers ; training means the cultivation of aptitude and for that we are dependent on our opportunities and ourselves."— *Trotter.*

Note.—Contributions are invited.

MONTHLY DINNERS

Monthly dinners are held in the College on the second Wednesday of each month. The following are entitled to attend with their guests. All Diplomates and students of the College, and Members of the Associations linked to the College through the Joint Secretariat. It is not necessarily intended that guests should be members of the medical profession.

The dinners will be at 7 p.m. on the following Wednesdays : December 8, 1948, January 12, February 9, March 9, April 6, May 11, June 8 and July 13, 1949. There is an inclusive charge of £1 5s. (including drinks), which must be sent with the application to the Assistant Secretary at least a week before the date of the dinner. The dress is Lounge Suit or Uniform.

DIARY FOR NOVEMBER
(15th—30th)

Mon.	15	3.45	DR. A. SCHWEITZER—The Reflex Control of Blood Pressure and Heart Rate.
		5.00	DR. B. D. PULLINGER—Cell Multiplication in Adult Tissues.
Tues.	16	3.45	DR. A. SCHWEITZER—Measurements of Cardiac Output and Factors Influencing it.
		5.00	DR. B. D. PULLINGER—Cell Multiplication in Adult Tissues.
Wed.	17		D.T.M. and H. Examination begins.
		3.45	PROF. PEDRO BELOU—Results obtained with Cinematography in colour for the objective interpretation of the Morphology of the Human Arterial System.
		5.00	MR. GEOFFREY KEYNES—Vicary Lecture—The Portraiture of William Harvey.*
Thur.	18	3.45	PROF. H. BARCROFT—Blood flow in the Limbs.
		5.00	DR. KEITH SIMPSON—The Pathology of Blunt Head Injury.
Fri.	19		D. A. Examination (Part II) begins.
		3.45	PROF. H. BARCROFT—Blood flow in the Limbs.
		5.00	DR. KEITH SIMPSON—Death from Vagal Inhibition.
Mon.	22	3.45	DR. F. K. SANDERS—Results of Nerve Section.
		5.00	PROF. J. H. DIBLE—Inflammation and Repair.
Tues.	23	3.45	DR. CUTHBERT DUKES—Imperial Cancer Research Fund Lecture — The Significance of the Unusual in the Pathology of Intestinal Tumours.*
		5.00	PROF. J. D. BOYD—Development of Urogenital System.
Wed.	24	3.45	PROF. J. D. BOYD—Development of Cardiovascular System
		5.00	PROF. E. C. DODDS—Sterol Metabolism—Pathology.
Thur.	25	3.45	PROF. E. C. DODDS—Sterol Metabolism—Physiology.
		5.00	PROF. J. H. DIBLE—Inflammation and Repair.
Fri.	26	3.45	DR. N. H. MARTIN—The Applied Physiology of the Parathyroid.
		5.00	PROF. G. S. WILSON—Non-pulmonary Tuberculosis.
Mon.	29	3.45	SIR CECIL WAKELEY—The Pancreas and its Relations.
		5.00	DR. L. E. GLYNN—Liver : Function Tests.
Tues.	30	3.45	DR. B. SCHOFIELD—Digestion.
		5.00	PROF. J. Z. YOUNG—Injury and Repair of Peripheral Nerves.

*Not part of courses.

DIARY FOR DECEMBER

Wed. 1   L.D.S. Examination (Properties of Dental Materials) begins.
      3.45   Dr. B. SCHOFIELD—Digestion.
      5.00   PROF. J. Z. YOUNG—Injury and Repair of Peripheral Nerves.

Thur. 2   L.D.S. Examination (General and Special Anatomy and Physiology) begins.
      3.45   Dr. J. WHILLIS—The Hip Joint and its Movements.
      5.00   Dr. R. G. MACFARLANE—The Hæmorrhagic States.

Fri. 3   D.P.M. Examination (Part I) and D. I. H. Examination (Part I) begin.
      3.45   Dr. J. WHILLIS—Intrinsic Muscles of the Hand.
      5.00   Dr. R. G. MACFARLANE—The Hæmorrhagic States.

Mon. 6   3.45   PROF. J. M. YOFFEY—The Nuclei of the Brain Stem.
      5.00   Dr. W. FELDBERG—The Autonomic Nervous System.

Tues. 7   3.45   PROF. F. GOLDBY—The Vagus Nerve and its Distribution.
      5.00   Dr. W. FELDBERG—The Theory of Chemical Transmission of Nerve Effects.

Wed. 8   3.45   PROF. S. ZUCKERMANN—The Female Reproductive Tract.
      5.00   Dr. G. BROWNLEE—Chemotherapeutic Drugs.
      7.00   Monthly Dinner for Fellows, Members and Licentiates (see p. 289).

Thur. 9   First Membership Examination, and L.D.S. Examination (Dental Mechanics) begin.
      5.00   SIR REGINALD WATSON-JONES—Robert Jones Lecture—The Reactions of Bone to Metal*

Fri. 10   D.P.M. Examination (Part II), D.L.O. Examination (Part I) and D.I.H. Examination (Part II) begin.
      3.45   Dr. H. F. BREWER—Some Considerations Regarding Blood Transfusion.
      5.00   Dr. G. BROWNLEE—Chemotherapeutic Drugs.

Mon. 13   3.45   Dr. E. L. PATTERSON—The Pelvic Floors and Walls.
      5.00   Dr. J. DOUGLAS ROBERTSON—The Disordered Metabolisms in Thyrotoxicosis and Myxoedema.

Tues. 14   3.45   MR. S. MOTTERSHEAD—The Thoracic Operculum.
      5.00   Dr. J. DOUGLAS ROBERTSON—Some Aspects of Calcium Metabolism in Health and Disease.

Wed. 15   3.45   PROF. C. McLAREN WEST—The Female Breast and its Development.
      5.00   Dr. D. J. BELL—Carbohydrate Metabolism.

Thur. 16   Pre-Medical Examination begins.
      3.45   PROF. T. NICOL—The Kidneys and Bladder.
      5.00   Dr. D. J. BELL—Carbohydrate Metabolism.

Fri. 17   D.L.O. Examination (Part II) begins.
      3.45   MR. CLIVE BUTLER—The Surgical Anatomy of the Rectum and Anal Canal.
      5.00   PROF. A. C. FRAZER—Fat Absorption and Metabolism.

Thur. 23   College Closed.

Tues. 28   College reopens.
      Last day for applications for election to Court of Examiners.

Fri. 31   D.P.H. Examination (Preliminary) begins.

*Not part of courses.

THE SURGERY OF THE SALIVARY GLANDS

Lecture delivered at the Royal College of Surgeons of England

on

22nd September, 1948

by

Sir Cecil Wakeley, K.B.E., C.B., D.Sc., F.R.C.S., F.R.S.E.

Senior Surgeon King's College Hospital and the Belgrave Hospital for Children, Surgeon to the Royal Masonic Hospital, Consulting Surgeon to the Royal Navy

THE SURGERY OF the salivary glands consists in the treatment of inflammatory conditions, calculi, fistulæ and various tumours.

The three salivary glands have much in common, they are all developed from the living epithelium of the primary mouth in essentially the same manner. The primordium of each gland is originally a solid cord of cells growing from the epithelium into the underlying mesenchyme. The cords branch and subdivide, lumina appear, and the apices of the terminal ducts finally become dilated to form acini. The proximal portion of the original outgrowth becomes the main duct. The rudiment of the parotid appears in embryos of 10 mm.—that is, about the sixth week of intra-uterine life. It commences near the angle of the mouth in the upper alveolo-labial sulcus, grows backwards over the outer aspect of the masseter muscle, the external carotid artery, the temporo-maxillary vein, and the facial nerve ; it finally expands in the recess between the lower jaw and the external auditory meatus and the mastoid process. The submaxillary and sublingual glands appear later as outgrowths from the epithelium lining the alveolo-lingual groove in the floor of the mouth, at about the 11 and and 12 mm. stages, that is about the seventh week of fœtal life. Whether the salivary glands are derived from ectoderm or entoderm is a question to which no certain answer can be given. If all structures developed from epithelium covering the maxillary and mandibular arches are ectodermal in origin, then the parotid glands, anterior part of the tongue, and the floor of the mouth and presumably also the submaxillary and sublingual glands, are derived from ectoderm, although some authors contend that the last named are endodermal. Mucin cells do not appear until the sixteenth week of fœtal life.

Complete absence of the salivary glands is a very rare condition. Xerostoma or dry mouth may occur in children and adults, occasionally in several members of the same family. This is not due to absence of the salivary glands, but to suppression of glandular secretion.

BACTERIAL INFECTION OF THE PAROTID GLAND

Inflammation of the parotid gland may be acute or chronic and in practically every case the infection passes from the mouth along the parotid duct into the gland.

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Acute suppurative parotitis may occur at any age, but usually in adults. In my experience the condition is most frequently met with in the insane, especially in those who have to be fed by the mouth or nose. These patients always have dry mouths, even when food is being administered. There is a definite lack of psychical juices and of appetite, and, indeed, a definite feeling of repulsion for food. Infection reaches the parotid via Stenson's duct, and the first sign is usually swelling and fluctuation of the gland. General resistance on the part of the patient is so poor that the temperature and pulse exhibit very little variation from normal. Early cases may respond to penicillin therapy and a frequent mouth wash, such as a weak solution of Milton. Daily treatments with deep X-ray have been found useful in some cases.

If pus formation is present early incision of the parotid fascia is essential, otherwise the pus finds its way to the surface by bursting into the external auditory meatus at the junction of the osseous and cartilaginous portions. These cases may prove fatal unless free incisions are made into the gland. The gland itself undergoes necrosis and large sloughs are formed ; these should always be removed.

POST-OPERATIVE PAROTITIS

This is now an exceedingly rare condition, and as its pathology is known it should entirely disappear. It is so rare to-day that students and nurses often do not see a single case during their training. In 10,210 operations performed at King's College Hospital between 1900 and 1910, 32 cases (0·313 per cent.) of parotitis occurred, all after abdominal operations ; while in 17,585 operations performed at the same hospital between 1918 and 1927 there were 18 cases (0·102 per cent.) of parotitis. This reduction is due to the fact that gastric and abdominal cases are more carefully prepared, and that intravenous therapy is administered frequently. Further, oral sepsis is now treated before any abdominal operation is contemplated, while before 1910 oral sepsis was neglected and dental treatment was almost unheard of in the wards of a hospital. To-day, with penicillin and the sulpha group of drugs, post-operative parotitis should never occur. However, should a case arise it is important to remember that incision should not be delayed until fluctuation can be elicited. It is only in the later stages of suppurative parotitis that fluctuation can be made out ; this is due to the fact that the parotid is encased in a very firm capsule derived from the cervical fascia, and the texture of the gland is firm. A vertical incision should be made through the skin which is undercut to expose the whole gland. Small multiple transverse incisions are then . made through the parotid fascia and the gland- explored with a small sinus forceps.

Lack of tissue fluids are an important factor in these cases of acute parotitis. It should be remembered that the total amount of saliva secreted in the 24 hours has been estimated at 2,000 c.cm. If the parotid glands are responsible for half of this, one gland would secrete 500 c.cm.

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in the 24 hours, or just over 20 c.cm. in an hour. Thus there is a continuous stream of secretion flowing down the parotid duct, and infection from the mouth is almost impossible in normal individuals. Should any factor interfere with this secretion the liability to infection increases.

CHRONIC OR RECURRENT PAROTITIS

Chronic parotitis is quite a common condition and occurs in children and adults. Infection from the mouth with streptococci and pneumococci is the usual cause. The orifice of Stenson's duct is often inflamed and œdematous. Pressure over the parotid gland may cause a flow of thick purulent saliva. In some cases the cause is due to a parotid calculus. Occasionally unilateral or bilateral parotid swellings are due to a large upper denture which causes irritation of the gums and obstruction of the orifice of Stenson's duct (Fig. 1).
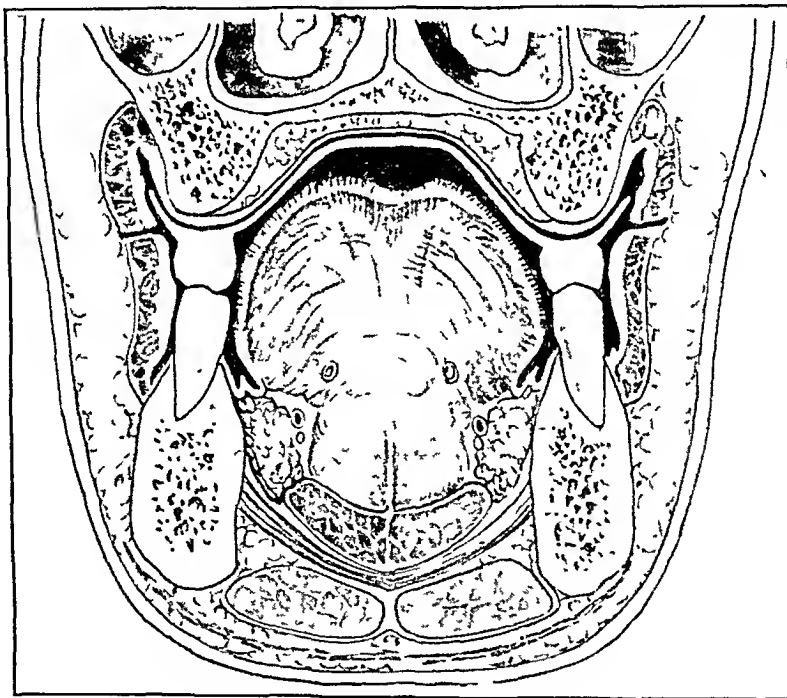
Fig 1.   Diagram showing relation of upper denture to the orifice of Stenson's duct.

A badly fitting denture which is not cleansed daily may also be a cause of recurrent parotitis. The remedy is a properly fitting denture and a daily mouth wash with a suitable antiseptic such as Milton.

If the condition does not clear up the duct should be investigated by injecting it with lipiodol and then having an X-ray taken (Fig. 2). In some children a state of congenital sialectasis may be present, the terminal tributaries of the parotid duct remain permanently dilated. This condition rarely calls for treatment.

Fig. 2.   Injection of lipiodol into parotid duct showing dilation of some of the terminal ducts.

SALIVARY FISTULÆ

The only fistulæ of practical importance are those in connection with the parotid gland and its duct.   Fistulæ of the submaxillary gland tend to heal of their own accord ; the cases which do not are easily treated by excision of the gland through a curved incision in the digastric triangle of the neck.

Parotid fistulæ may be divided into two groups :

(1) fistulæ of the duct.

(2) fistulæ of the gland.

Fistulæ of the parotid gland and duct are most frequently caused by injury or suppuration around a calculus.   Operations for removal of glands in the upper part of the neck may cause injury to the lower part of the parotid.   A small fistula may result which tends to heal at once ; if, however, the wound becomes infected a permanent fistula invariably results.   The nearer fistulæ of the parotid duct are to the gland the more difficult they are to cure.   They never tend to heal spontaneously, and the portion of the duct in front of the fistula frequently becomes stenosed and sometimes obliterated.   Should the fistula be situated in front of the masseter muscle operation will often effect a cure.   In recent cases, such

as a stab injury, the wound should be opened up and the two ends of the duct isolated. A piece of stout silkworm gut is passed from the mouth through the orifice of Stenson's duct and out on the face ; it is then passed into the proximal portion of the duct and thus acts as a dowel (Fig. 3).
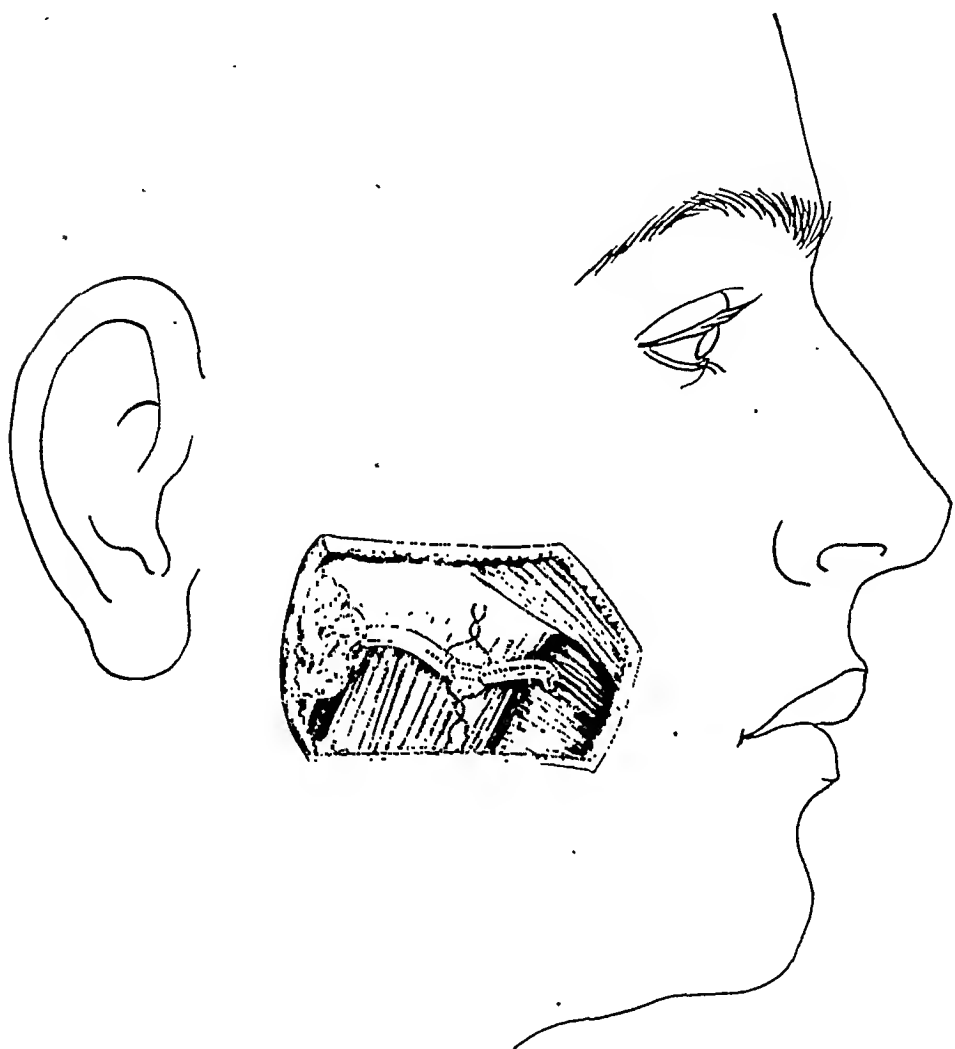
Fig. 3.   Method of suturing the parotid duct over a piece of silkworm gut.

The wall of the duct is sutured over the piece of silkworm gut, and the wound in the skin closed. In order to prevent a clot forming in the duct at the line of suture the silkworm gut is retained in situ until the patient recovers from the anæsthetic. This method is only of use when the wound is recent. Fine steel wire or nylon may be used instead of

silkworm gut, but catgut should never be used as it swells and may cause complete blocking of the duct.

In old-standing cases of pre-masseteric fistula the following procedure will sometimes suffice : A straight needle threaded with silk is passed through the fistula into the mouth ; the needle is then unthreaded and the piece of silk outside the mouth is threaded on to it. The needle is then inserted through the fistula into the mouth a second time. The two ends of the silk are then tied in a knot. The included piece of tissue which is strangulated by the suture dies and sloughs, and by this means an opening is made into the mouth. As the parotid secretion has now a free vent into the mouth, the fistula heals (Fig. 4).

Fistulæ of the parotid duct which are situated in the proximal part—namely, over the masseter muscle—are, as may be imagined, very difficult to cure, and nearly 30 different operations have been devised in attempts to restore the continuity of the duct. Most of these operations leave considerable scarring on the face, frequently damage the lower branch of the facial nerve, causing paralysis of the muscles at the angle of the mouth, and rarely cure the condition.

A simple procedure which is always worth trying consists of passing a small, fine, malleable probe from the mouth along the duct and out of the fistula on the face. A piece of silk is attached and drawn out on the face. To the end of the silk is attached a fine piece of rubber drainage tubing, and this is drawn out of the fistula, leaving one end in the mouth while the other is projecting on the face. Saliva may find its way along the side of the drainage tube into the mouth. After a few days the drainage tube is drawn so far into the mouth that it no longer projects from the fistula. Finally, after a week, it is withdrawn altogether. In some cases the result of this method is admirable and the fistula remains completely closed.

There is only one certain way of closing a fistula of Stenson's duct when sepsis is present and that is by causing a cessation of secretion of the parotid saliva. This may either be done by radiotherapy or avulsion of the auriculo-temporal nerve.

Radiotherapy rarely fails to cure and is the simpler form of treatment.

Avulsion of the auriculo-temporal nerve, which is the secreto-motor nerve to the parotid gland, was first advocated by Leriche many years ago and gives good results. However, the operation is difficult and it is rarely performed to-day. In some 20 cases in which I have avulsed the nerve a permanent cure was obtained in 17 cases. I have used a modification of Leriche's method; instead of a horizontal incision in front of the external auditory meatus, I use a vertical one. This gives a much better exposure, and the superficial temporal artery and its venæ comites are not so liable to injury. As the nerve is situated immediately on the deep aspect of the artery, if the latter structure is retracted it can easily be ex-
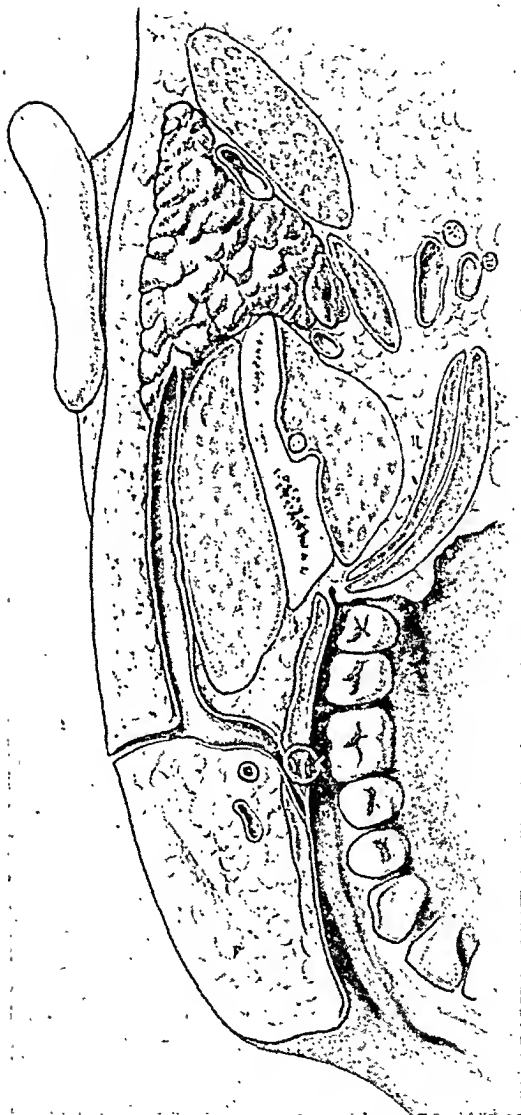
Fig. 4.   Method of dealing with a pre-masseteric fistula of the parotid duct.

posed ; the nerve is then divided with a knife, the proximal portion grasped with a pair of Spencer-Wells forceps, and as much of it as possible avulsed by firm traction.

Fistulæ of the parotid gland sometimes tend to heal of their own accord, those which do not are either treated by radiotherapy or avulsion of the auriculo-temporal nerve.

SALIVARY CALCULI

Calculi may be formed in any of the salivary glands but the submaxillary is the usual site. The age incident is usually between 20 and 40. Men are affected to a greater extent than women in the proportion of three to one. The size of the calculi varies greatly ; they may be as small as grains of sand or as large as a bantam's egg. More commonly they vary from the size of a split pea to that of a date-stone. They are usually single and in a small percentage of cases only does recurrence take place after removal. As a rule, calculi in the glandular tissue are spherical or oval, while those in the ducts are elongated and resemble date-stones. In the ducts they may be multiple and are then usually arranged end to end, the opposed surfaces being faceted. The surface of the calculus may be finely or coarsely granular and is usually of a dirty yellowish-grey to a whitish colour. The structure varies considerably.

In a fair proportion of cases a foreign body has been found as a nucleus. Some calculi are laminated, but in my experience this is uncommon. A large majority of stones from the salivary glands and ducts are composed of calcuim phosphate and calcium carbonate. A complete analysis of my last 30 cases of submaxillary calculi gives the following composition :

Calcium phosphate	..	..	..	..	.. 74·3 per cent.
Calcium carbonate	..	..	..	..	.. 11·1 per cent.
Soluble salts ..	..	..	..	..	:. 6·2 per cent.
Organic matter ..	..	..	..	..	.. 6·2 per cent.
Water ..	..	..	..	..	.. 2·2 per cent.

Ætiology.—The cause of calculus formation in the salivary glands and ducts has been, and still is, the subject of much discussion. That some constitutional condition may predispose to calculus formation seems very improbable. If a general cause is in any way responsible one would expect it to exert its influence upon more than one gland, and to give rise to calculi in several glands or ducts. I have only found a few cases recorded in the literature in which calculi were found in more than one gland or duct in the same person. When foreign bodies form the nucleus no doubt they are the initial cause in the formation, as stones in the urinary bladder form round an unabsorbed catgut ligature. Foreign bodies, however, must not be regarded as the sole cause, nor must it be thought that any foreign body introduced into a salivary gland or its duct will of necessity cause the formation of a calculus. The literature abounds with cases in which a foreign body such as a piece of straw, grass, or hair

has been lodged in the salivary ducts' for long periods of time without giving rise to any calculus formation.

An analysis of the recorded cases of salivary calculi published up to the present time brings out the following figures :

Submaxillary gland and duct	64·1 per cent.
Parotid gland and duct	19·7 per cent.
Sublingual gland and duct	16·2 per cent.

It is necessary, therefore, to explain the far greater frequency of calculi in the submaxillary gland and Wharton's duct than in the other salivary glands and their ducts. It must be conceded that, owing to the greater size of the duct and the position of its orifice, foreign bodies such as tartar and particles of food can enter Wharton's duct more easily than they can the ducts of the other salivary glands. The composition of tartar is very similar to that of calculi. Therefore, although tartar may quite often be a determining factor, it would be quite impossible to demonstrate it. Similarly, food particles may enter the duct, undergo decomposition there, and simply add to the percentage of organic matter in the calculus without other evidence of their presence.

If a salivary calculus is carefully cut through its centre and a culture is made from the interior, bacteria are nearly always found. It might be thought that bacteria were the actual cause of the calculus, but this certainly cannot be the case, since, if infection alone were the important factor, calculi would occur more frequently in the gland and duct which is most often the seat of infection—namely, the parotid and its duct. Bacteria probably play a part in the formation of calculi by decomposing the proteids in the saliva. It is a well-known fact that if saliva is exposed to the air for a short period of time carbon dioxide escapes from it and a thin film of calcium carbonate soon forms on the surface. Therefore the removal of carbon dioxide alone is sufficient to precipitate the calcium salts. When bacteria decompose the proteids in saliva, ammonia is produced, and probably immediately unites with the carbon dioxide held in solution ; thus a condition favourable for calculus formation occurs. If this be so, it is quite reasonable to conclude that bacteria cause, indirectly, a precipitation of the calcium salts in the saliva by increasing the alkalinity of the saliva and removing carbon dioxide.

The composition of the saliva from the submaxillary gland allows easier precipitation of calcium salts than does that of the parotid or sublingual. The factors which predispose to a precipitation of the calcium salts in the submaxillary gland are :

(1) high percentage of solids ;
(2) high percentage of organic matter ;
(3) greater degree of alkalinity ;
(4) low content of carbon dioxide.

It is sometimes debated whether the " idiopathic " formation of salivary calculi ever occurs. To me the question appears futile. If, by the term " idiopathic," is meant that calculus formation occurs in a perfectly

normal secretion in a perfectly normal gland or duct, the answer must clearly be in the negative. On the other hand, it does not seem necessary to postulate the entrance of any gross foreign material, since alterations in the reaction of a system of colloids and inorganic electrolytes are frequently accompanied by precipitation.

The lamination observed in the precipitation of certain salts in the presence of gels, and known as the Licsegang phenomenon, is profoundly influenced by the reaction of the gel. That variations in hydrogen-ion or hydroxyl-ion concentration in different media can be brought about by bacterial action is too well-known to need comment. Hence the introduction of even a single micro-organism and its subsequent multiplication may set such a disturbance in the equilibrium of an electrolyte-colloid system as to initiate precipitation. How far similar phenomena can be brought about by " filter-passers " is a question which time and experiment alone can solve. It is at any rate of theoretical interest, since these elusive entities are now considered to be important factors in the ætiology of influenzal and various catarrhal conditions. That colloids do play an important part in the formation of salivary calculi is at any rate suggested by their greater frequency in the submaxillary glands, where organic colloid material is present in greatest abundance.

PAROTID CALCULI

The parotid gland is not commonly the seat of calculi, but calculus formation in Stenson's duct is by no means rare. Multiple calculi are more common than single. In one case which came under my care some 16 stones were removed from the parotid duct. The calculi are always opaque to X-rays. Abscess formation around long-standing calculi is quite a common complication, and should the abscess open externally, a fistula results. The massetcric portion of Stenson's duct is the most frequent situation for calculi, and their removal necessitates an external incision. Fistulæ may follow, but are rare if the incision is longitudinal and closed by stitches after the removal of the stones. If calculi are present in the pre-masseteric portion of the duct they may be liberated by an incision through the buccal mucous membrane. Stricture may follow the removal of calculi from Stenson's duct and this can be demonstrated by the injection of lipiodol along the duct, and dilatation of the stricture may be performed by a thin metal probe.

SUBMAXILLARY CALCULI

In contrast to the parotid calculi found in the submaxillary gland or its duct are usually single (Fig. 5). The single calculus may be seen in a variety of shapes according to the position in which it is lodged, either in the gland or in the duct. If it is in the gland it is usually rounded in appearance (Fig. 6), while if it is partly in the gland and partly in the duct it assumes a tapering form, the " Comma Calculus " (Fig. 7) ; the larger part of the calculus being in the gland while the smaller portion extends
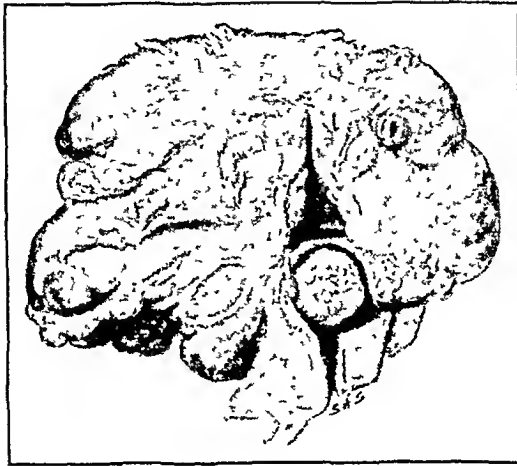
Fig. 5. Salivary calculus in sub-maxillary gland, operation specimen.

Fig. 6. Calculus removed from submaxillary gland.
Fig. 7. " Comma Calculus " removed from submaxillary gland and its duct.

Fig. 7.

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into the duct. This type is quite common, and the thinned distal portion is liable to be fractured and may then pass along the duct into the mouth, while the larger proximal portion remains in the gland. Such a calculus in the submaxillary gland cannot be palpated owing to the amount of fibrous tissue surrounding it, but it can nearly always be demonstrated by X-rays. If, however, the calculus is in Wharton's duct it is usually moulded by the muscular wall and may be said to form a cast of the duct (Fig. 8). Lastly, if a calculus is formed at the orifice of Wharton's duct, or a small one passes along the duct and becomes impacted there, it is nearly always cylindrical (Fig. 9).

Many examples of calculi surrounding foreign bodies have been described. Perhaps one of the best examples of a specimen is in the museum of this College (No. 2234.1 ; Fig. 10).
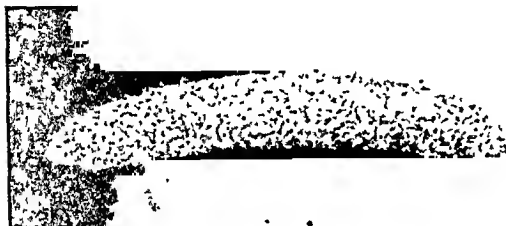
Fig. 8. Calculus removed from Wharton's duct.

Fig. 9. Calculus removed from orifice of Wharton's duct.

Fig. 10. Calculus formation surrounding a fish-bone removed from Wharton's duct. Specimen R.C.S. Museum No. 2234.1.

It consists of a small fish-bone which was found projecting from the orifice of Wharton's duct ; it is encrusted with phosphates for more than half its length.

All salivary calculi are radio-opaque (Figs. 11, 12 and 13).

The treatment of submaxillary calculi is quite simple. Calculi in the gland usually necessitate excision of the gland, because there is always considerable fibrosis of the glandular alveoli due to the presence of the calculus and the back pressure exerted thereby. If the stone is in the duct

Fig. 11.   Skiagram showing large calculus in the floor of the mouth near the orifice
of Wharton's duct.

Fig. 12.   Skiagram showing calculus in
Wharton's duct.

Fig. 13.   Skiagram showing small cal-
culus in Wharton's duct.

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an incision through the mucous membrane of the mouth into the duct is all that is required, and this can easily be performed under local anæsthesia. Calculi may re-form in either the gland or duct after an operation on the duct itself; oral sepsis plays a very important part in such cases. Stricture formation may follow ulceration of the wall of the duct, the ulceration being due either to the calculus or to the incision made in the duct. Incisions within the mouth cavity must always, even in the best circumstances, become infected owing to the innumerable bacteria which are invariably present.

SUBLINGUAL CALCULI

Calculus formation in the sublingual gland and its duct is a rarity and very few cases are recorded. I have only seen two cases, both in children under 10 years of age and both associated with cystic distension of the gland.

TUMOURS OF THE SALIVARY GLANDS

Tumour formation in the salivary glands is quite common, the incidence being parotid, submaxillary and sublingual in order of frequency.

ANGIOMATA

Angiomatosis of the salivary glands is a rare condition but by no means unique. There are several cases recorded in surgical literature; Virchow in 1889 refers to two cases of parotid angiomata. The condition occurs mostly in children, and in those cases which have been described in adults, there is generally a history of the condition having been present since birth. For instance, Gascoyen described a case of angioma of the parotid in a man aged 44 years. The tumour was congenital and gradually increased in size so that it eventually caused the death of the man by suffocation.

I have seen only five cases and these occurred in children under six years of age at the Belgrave Hospital for Children. In all these cases the tumour was definitely lobulated and microscopically resembled fat, with many dilated and tortuous vessels running in every direction through it. Microscopically, the glandular structure of the lobules was seen to be replaced by a delicate network of capillaries, the walls of which consisted of a single layer of endothelium.

Magnac described a case of angioma of the submaxillary gland in a girl aged five years. A swelling had been present below the right side of the lower jaw since birth, and at the age of five it commenced to increase in size. It was thought to be a retention cyst of the submaxillary gland. After excision, the tumour was found to be an angioma which was in close contact with the gland but had not penetrated it.

In my personal series of 102 cases of salivary tumours in the last 33 years I have seen only two cases of angiomata of the submaxillary gland.

ADENOMATA

Adenomata of the salivary glands are uncommon and in my personal series only 10 cases could be designated to come under this title; eight of these occurred in the parotid and two in the submaxillary gland. These tumours are always encapsulated and may be cystic or solid. They are usually alveolar in structure and reproduce the acini of the gland. There can be no doubt that these rare tumours show a tendency to undergo malignant change into adenocarcinoma and it is for this reason that these tumours should always be removed by surgical excision. As is the case with adenomata elsewhere in the body these tumours are radio resistant.

SO-CALLED " MIXED TUMOURS "

The majority of all salivary tumours fall in this group which originally were thought to be teratomatous in nature, then were considered to be endotheliomata and at the present time the concensus of opinion is that they are epithelial in nature. Willis makes use of the terms pleomorphic salivary adenomas and adenocarcinomas.

These tumours are most common in the parotid gland and are characterised by the presence of spaces containing material resembling cartilage. The tumours are derived most frequently from the ducts of the glands but in a few cases from the secreting cells. No cartilage is to be found in these tumours; but in the substance which has been described as cartilage, the matrix is formed by a change in the mucin of the tumour, whereby it loses its fibrillar appearance and its power of staining deeply with special dyes.

Although most pathologists believe in the epithelial nature of these tumours, there are still some who cannot agree to classify all mixed tumours of the salivary glands under that heading. ·

Mixed tumours are equally common in either sex and I know of no age incidence; they may occur in childhood or in old age.

These tumours are usually situated in the superficial portion of the parotid gland, are freely movable in the gland substance, are coarsely nodular (Figs. 14, 15, 16 and 17) and vary in consistency in different parts.

The facial nerve in its course through the parotid gland is deeply placed and hence is not pressed on by these tumours unless they undergo malignant change. They have a definite capsule and outside this the gland tissue is somewhat compressed to form an extra pseudo-capsule. This fact is important from the point of view of treatment. If excision is undertaken and the tumour is removed, a parotid fistula rarely results; this is due to the fact that the compressed gland substance around the tumour prevents any escape of secretion.

These tumours show a definite tendency to recur even after a long interval and are thus considered by many surgeons to be potentially malignant. Therefore the best form of treatment should be local excision combined with radiotherapy.
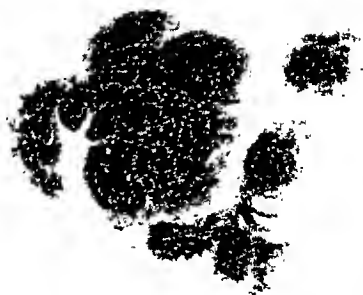
Fig. 14.

Fig. 15. Parotid tumour removed from patient depicted in Fig. 14 showing nodular outline of the tumour.

Fig. 14. So-called mixed tumour of the parotid gland. Five years' history showing nodular outline of the tumour.

Fig. 16. So-called mixed tumour of the parotid in a patient aged 52. Tumour had been present 10 years.

Fig. 17. So-called tumour of the sub-maxillary gland.

As a rule these so-called mixed tumours are of slow growth and frequently many years elapse before the patient seeks advice or will consent to operation. Rapid increase in the size of the tumour or the onset of facial paralysis may be the determining factor which induces a patient to seek treatment (Fig. 18). Unfortunately both these signs are usually consequent on malignant change.

Fig. 18. Carcinoma of the parotid in a patient aged 62 who had possessed a tumour in the parotid for some 35 years.

Salivary sarcomas and adeno-lymphomas are rare tumours and do not necessitate any remarks.

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THE SURGICAL APPROACH TO HYPERTENSION

Hunterian Lecture delivered at the Royal College of Surgeons of England

on

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by

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INTRODUCTION

WITH THE INTRODUCTION of the sphygmomanometer in 1896 by Riva-Rocci, a new scientific approach to a medical problem became possible, and the raised blood pressure which so often accompanied chronic renal disease was demonstrated. Nearly twenty years later Albutt and others recognised the existence of a raised blood pressure in the absence of renal disease. Recently, many more ætiological factors have been demonstrated and the causes of hypertension have been divided into three main groups, renal, cerebral and endocrine, all of which may be called secondary, and a fourth group which is growing progressively smaller as clinical and experimental investigation bears fruit, the so-called " Essential Hypertension." From the last group certain cases of unilateral renal disease associated with hypertension have recently been removed.

STANDARDS OF NORMAL BLOOD PRESSURE

The common standard of normal systolic blood pressure is approximately 110-120 in adolescence, rising with age so that the upper limit of normality is frequently expressed as 100 plus the age. This upper limit has been calculated statistically on a large cross-section of the population. The fallacy of this standard of normality has been shown by Robinson and Brucer (1939) in a critical examination of nearly 12,000 persons examined with a view to life insurance or in one of the free annual medical examinations granted by some American companies to their clients. They pointed out that in any cross-section of the population, there are always a certain number of abnormals and unless these abnormals are eliminated, no statistically true average can be found. They considered that their sample of the public was not completely representative as it necessarily covered only those income groups who were in a position to take out a life insurance policy for £200 or more. With this proviso, however, it included all income groups, classes and professions.

At the time of the survey (1939) a blood pressure reading of more than 140/90 was being recognised as abnormal and they have therefore eliminated all persons with blood pressure readings over this figure. The results are astonishing when considered in the light of previously held views. The average blood pressure in the delimited sample which was roughly $\frac{7}{8}$ of the whole group, rose to 120/80 in adolescence and then

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remained constant throughout all age groups, while the average blood pressure of the whole sample rose steadily to reach a level of 160/120 at age 75. They found that it mattered very little whether the limiting line was drawn at 150/100 or 130/85. The net result was the same : an average normal blood pressure of 120/80 which did not rise with age.

The study also included a more detailed series of annual examinations over a period of ten years in 500 policy holders. This showed that transient rises in the blood pressure or isolated high readings in the early years were almost invariably followed later by a permanent rise— that is to say were an infallible sign of incipient hypertension.

In support of their contention that the normal blood pressure does not exceed 120/80 they were able to show that the actual mortality rates were lowest in those people with the lowest blood pressures and that far from hypotension being a disease entity it was, in fact, a very desirable physiological state.

This statistical investigation is of extreme importance for it cuts at the roots of our previous standards of normality. Nevertheless, it has been criticised by Treloar (1940) who suggests that in the detailed study of 500 individuals, there is too wide a variation of readings and that both normals and abnormals—that is, actual hypertensives—have been included in the figures.

ÆTIOLOGY OF HYPERTENSION

The causes of hypertension are many and varied and have been subjected to a variety of classifications. In many cases it is very difficult to assign a cause and these must be put into an unclassified group or called " essential." In the present circumstances the simplest classification is perhaps the best and there is much to be said for that advocated by de Takats, Graupner, Fowler and Jensik (1946), which is as follows :

1. Non renal   (a)   Neurogenic
                       (b)   Endocrine
                       (c)   Atheromatous

2. .Renal   (a)   Glomerulonephritis
                       (b)   Pyelonephritis
                       (c)   Polycystic kidney
                       (d)   Pre-eclampasia
                       (e)   Scarlet fever
                       (f)   Rheumatic fever
                       (g)   Hypoplasia and atrophic pyronephritis
                       (h)   Other types of unilateral renal disease

3. Unclassified   According to de Takats, the unclassified group
    or essential   embraces approximately 40% of all cases.

Two ætiological factors are known which influence the development of essential hypertension. The first is that of race (Fishberg 1944). Hypertension is almost unknown among oriental peoples and is rare in

African negroes living in their natural surroundings. It is, however, common in African negroes living in the large cities of the United States.

The other factor of significance is that of heredity. Platt (1947) has recently attempted to show that cases of hypertension without a family history are not essential hypertensives. For this investigation he has carefully analysed the histories of 116 cases of hypertension and has divided them into four groups according to whether the family history was positive, probable, incomplete or negative. The results are shown graphically and are very instructive. In 78 cases of essential hypertension he could find only five cases with a negative family history. These five cases are analysed in detail and in only one of them does the diagnosis rest on unequivocal clinical and histological evidence. As a result of this study, Platt concludes that " the evidence is compatible with the hypothesis that essential hypertension is a hereditary disease conveyed as a Mendalian dominant with a rate of expression of more than 90 per cent."

MECHANISM OF HYPERTENSION

Despite the amount of work which has been done in hypertension, the mechanism of hypertension is still obscure. Goldblatt (1934) in his notable work on renal circulation, showed that by diminishing the blood supply to one kidney, a state of renal hypertension could be induced despite the presence of a normally functioning contralateral kidney. This hypertension was not influenced by a section of the splanchnic and sympathetic nerve fibres going to the kidney (Goldblatt 1937). This work has been amply confirmed by others and Page (1939) has shown that a similar effect can be produced by surrounding the kidney with cellophane which produces a constricting perinephritis.

As a result of this demonstration that ischæmia in one kidney could produce hypertension, work was directed along two lines ; firstly at isolating the substances produced in the kidney and responsible for arteriolar spasm, and secondly at detecting clinical cases in which unilateral renal disease was a causative factor. Both lines of investigation have borne fruit. Page and Helmer (1940) have isolated and crystallised a pressor substance, " angiotonin," from an ischæmic kidney and numerous investigators have produced instances of unilateral kidney disease associated with hypertension in some of which the hypertension has been relieved permanently by nephrectomy.

Langley and Platt (1947) have recently reviewed the literature and have shown that the commonest unilateral lesions associated with hypertension are hypo-plasia and atrophic pyelonephritis and that in these cases there is a very good chance of curing the patient of hypertension by nephrectomy.

We have investigated three cases of hypertension associated with unilateral renal disease during the past twelve months.

One of these was a case of atrophic pyelonephritis which responded well to nephrectomy. The second case was one of a gross pyonephosis which

probably had no ætiological connection with hypertension. The third was a case of double kidney in one side, the upper half of which was hydro-nephrotic. In this case the hypertension was probably due to the hypoplasic upper kidney but renal disease secondary to arterial spasm was already advanced and function was reduced. Had this case been treated two or three years earlier the result might have been as successful as case 1.

Case I. C. J. Age 13 years. Sex Female.

C/O   Attacks of vomiting at intervals for 12 months.

P/H   Whooping cough, chicken pox, scarlet fever and diphtheria. Chorea at 3 years of age.

F/H   Negative.

H/P/C   Two weeks before admission she developed an abscess under the left arm which burst. A few days later she complained of generalised pains and intermittent hæmaturia.

O/E   Clinical examination showed a pale child with a large, red swelling in the left axilla which did not pulsate. The blood pressure was 270/215. Exudates were present in both optic fundi. There were no other abnormal physical signs.
        Pathological investigations were as follows :
            Hæmoglobin   60%
            White blood cells 9,500 per cu. mm. with 88% polymophonuclear leucocystosis.
            The urine contained 0.5 gm. of albumen per 100 ml., and very many red blood corpuscles.
            The blood urea was 32 mgm. per 100 ml.
            An intravenous pyelogram showed that the left kidney was secreting normally but that there was no function on the right side.

20.12.46.   The right loin was explored surgically but no kidney was found.

24.12.46.   Axillary swelling increasing in size. Cystic. No pulsation. Median nerve now involved by pressure.

6.1.47.   Swelling now dusky red. Left wrist-drop present.

30.1.47.   Axillary swelling explored and found to be a false aneurism. The clot was evacuated and the defect in the arterial wall sutured.

3.3.47.   Cystoscopy and retrograde pyelogram on the right side. The calyces are blunted and bunched together. The renal outline is not seen.

24.3.47.   Right loin explored again, right kidney found and removed.

Pathological Report. The kidney was very small and pelvis slightly dilated. Histological section shows practically no functioning renal parenchyma. The glomeruli are almost totally hyalinised and some of the tubules are completely atrophied. Others appear to be open but filled with a hyaline eosinophile material. There is marked interstitial fibrosis

and infiltration by lymphoid elements. Subacute pyelitis is also apparent. The arteries and arterioles show well-marked hypertensive changes.

1.5.47.   Blood pressure 145/125 ; discharged from hospital.
4.12.47. Blood pressure 120/85. No headaches, vomiting or hæmaturia. The left hand becomes very blue in the cold weather and there is some residual paresis of the small muscles of the hand. On warming, the circulation improves and muscular power becomes almost normal.

Upper thoracic sympathectomy is being considered.

Fig 1.   Case 1. Excretion pyelogram.

Fig. 2.   Case 1.   Retrograde pyelogram.
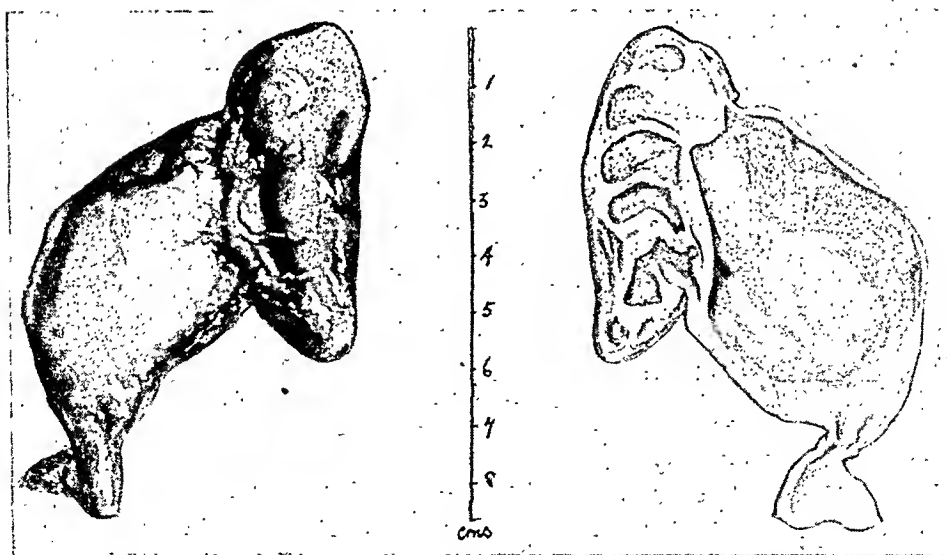
Fig. 3. . Case 1.   Specimen : an atrophic hydronephrotic kidney.

Case II. S.G. Age 52 years. Female. Unmarried.

Admitted 25.4.47.

History given by sister.

The patient complained of severe headaches for the last two years and for the last year has been known to have a high blood pressure. Two weeks before admission she developed sudden loss of speech and severe headache, followed by a period of stupor lasting 12 hours. On admission, her speech was beginning to return and she was able to say " yes." On 24.4.47 she had severe headache followed by a period of confusion.

F/H   Nothing definite.

P/H   Nothing significant.

O/E   General condition good. No cyanosis, dyspnoea or venous congestion. Apex beat 5 inches from the midline in the fifth space. Blood pressure 250/140. All reflexes exaggerated and plantar flexor. Optic fundi shows bilateral papilloedema. Is able to write sensibly.

28.4.47.   Speech almost normal. Blood pressure 190/100.

1.5.47.   Blood pressure 235/135. Complaining of severe headache.

7.5.47.   Urea concentration test. Maximum concentration 1 gramme %. Blood urea 50 mgm. %.

12.5.47.   Intravenous pyelography. No excretion on right side. Several shadows on left side suggestive of renal calculi.

29.5.47.   Cystoscopy. Slight cystitis. Right ureter could not be catheterized.

3.6.47.   Urea concentration test. Maximum concentration 2.25%. Blood urea 48 mgm. %.

5.6.47.   Refused further examination. Discharged at her own request.

5.9.47.   Complaining of pain in her right loin. Severe pain on micturition and frequency. On examination—very tender in right loin but no mass palpable. Blood pressure 210/145.

10.9.47.   Cystoscopy. Acute cystitis. Right ureter catheterized and retrograde pyelography performed. There was poor visualization of the calyces but pelvis was dilated. Stones were present in the pelvis which was very low and there were a group of shadows just below the pelvis. These were thought to be calculi isolated in a dilated calyx.

Comment : It was considered that nephrectomy should be undertaken for an obvious surgical indication. It was considered possible but unlikely that this would have some effect on the degree of hypertension.

24.9.47.   Nephrectomy under general anæsthesia, through Reid's incision. A massive pyonephrosis was discovered and delivered. It was not very tense. There was a good deal of perinephritis. Nephrectomy was performed and the wound drained. Convalescence was satisfactory until 18.10.47.

18.10.47.   Sudden epileptiform convulsion. Unconscious for 10 minutes. Blood pressure systolic; higher than 260. Diastolic 140. All reflexes exaggerated. Plantar reflexes extensor. Convalescence satisfactory.

3.11.47.   Discharged.

14.11.47.   Seen in the out-patient department.
Blood pressure 195/120.
Headaches still present occasionally.

Case III. J. S. Age 40 years. Male. Married. Two children.

Complaining of headaches for the last three years, not increasing in severity. Had a remission of twelve months during this period.

P/H   An attack of urinary infection in 1941, which responded to sulphonamides. A right ureterocele was discovered and excised with diathermy through a suprapubic cystostomy.

F/H   Negative. Wife and children alive and well.
Father died following abdominal trauma.
Mother died aged 80—cause unknown.

H/P/C   Frontal and occiptical headaches for the last three years. Has lost 2½ stone in weight in two years. Three years ago, was found to have a raised blood pressure. Four months ago, developed partial motor aphasia for three days; no cough, pyrexia, rheumatic pains or dizziness.

O/E   Heart enlarged, apex beat 5 inches out, fifth space. Blood pressure variable; never less than 200/135. No other abnormal physical signs.
Urine : moderate amount albumin present.
Blood urea : 55 mms. per 100 ccs.
Urea concentration test :
    Before administration of urea 1.2%.
    Three hours after administration of 15 grammes of urea, 1.6%.
Pentothal test :
    Minimum blood pressure level after 1 gramme—150/120.
Intravenous pyelogram :
    Moderate function on right, good function on left.

A very faint shadow could be seen, suggesting double ureter and double kidney on right side, the upper part being hydronephrotic. The ureteric shadow attached to this kidney was very wide but excretion in this part of the kidney was extremely poor.

Cystoscopy.   Left ureteric orifice normal. Right ureteric orifice grossly deformed and overhung by a curved shelf, beneath which two blind pits were seen, into neither of which a catheter could be passed.

2.12.47.   Operation. Right nephrectomy through Reid's incision. The lower part of the kidney was smaller than normal with a very
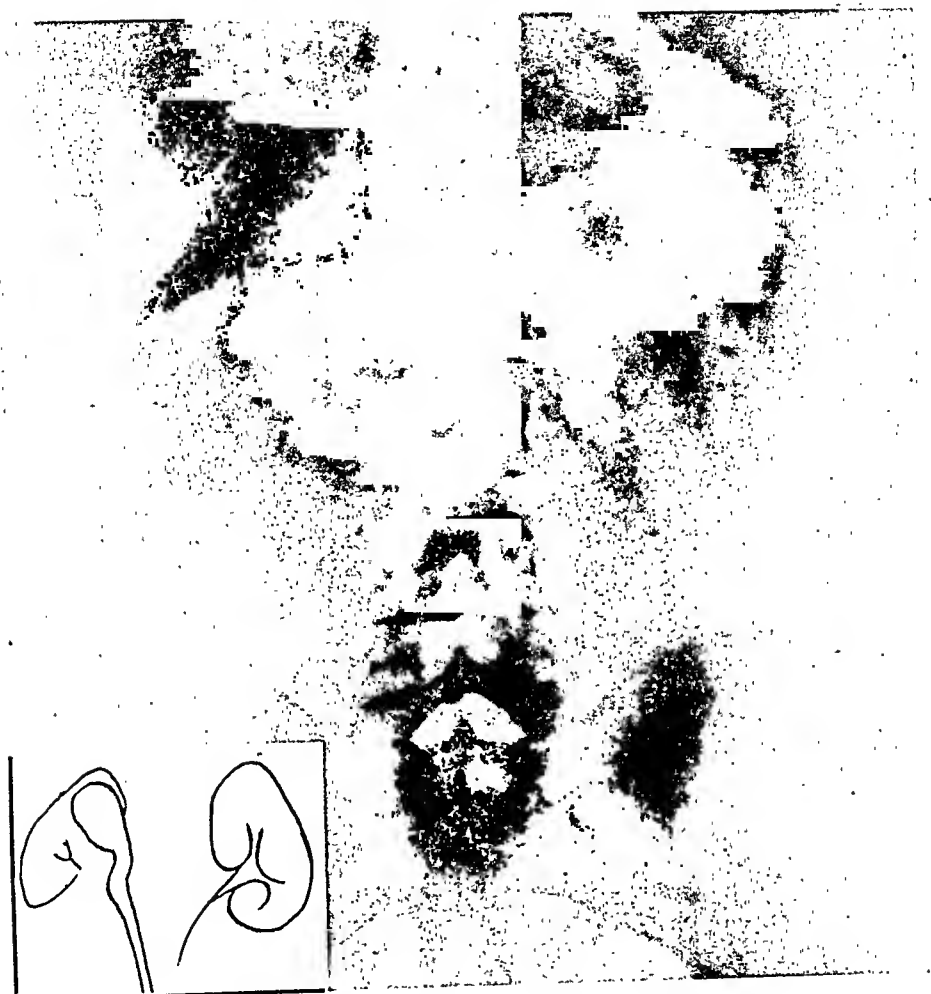
Fig. 4. Case III. Excretion pyelogram at 45 minutes.
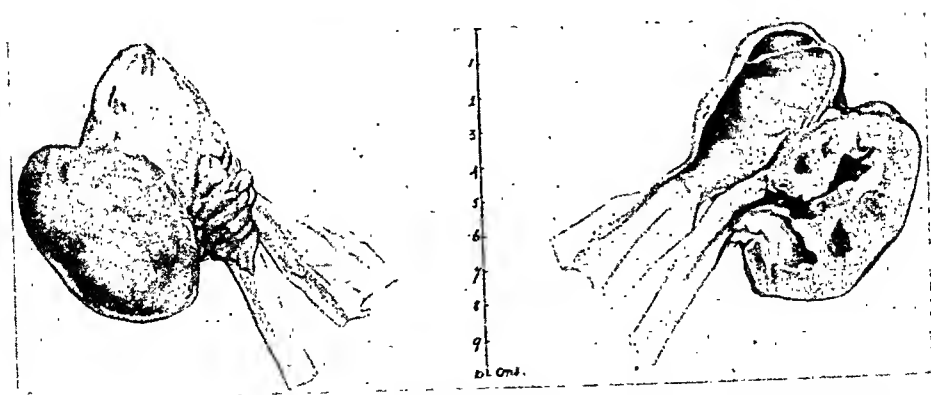
Fig. 5. Case III. Specimen : a small hypoplastic hydronephrotic upper half kidney.

granular surface. The upper half was small but the attached ureter was approximately half an inch in diameter.

Specimen. The kidney is in two parts. The upper is completely hydronephrotic and reduced to a thin shell with very little renal substance left. The lower half is contracted and the capsule has stripped leaving a granular surface characteristic of the kidney of advanced hypertensive disease. The arterioles are very prominent.

Histologically there is no evidence of any inflammatory lesion in either half of the kidney and the upper half is regarded as being hypoplastic rather than as an example of atrophic pyelonephritis.

Post-Operative Course. Recovery was very satisfactory. The blood pressure fluctuated considerably and occasional readings as low as 150/90 were recorded. Symptomatically, the man was much relieved, but it seems unlikely that this relief will be permanent for it must be assumed that the left kidney is in the same condition as the lower half of the right one.

Langley and Platt (1947) have tabulated the results of nephrectomy or hypertension associated with unilateral renal disease. The results suggest that nearly half the cases are successful, but it must be realised that many unsuccessful cases do not reach the literature. They also show that cases in which there is a positive family history of hypertension are unlikely to be successful. They also give a pathological analysis which shows that more successful cases fall into the group of atrophic pyelonephritis than into any other group.

Consideration of our own cases and of other published cases leads us to the conclusion that before a case of hypertension can be attributed to unilateral renal disease there must be :

    1. Unequivocal evidence of a unilateral lesion.

    2. Absence of a family history.

Two other criteria should be fulfilled if relief is to be expected from nephrectomy.

    3. The patient should be young.

    4. The hypertension should not have persisted for more than two years.

In our cases, all four criteria were fulfilled in Case I and in this case the result was extremely gratifying. In Case II, the criteria 2 and 3 were not fulfilled, while in Case III, criteria 3 and 4 were not fulfilled.

One unfortunate result of Goldblatt's work has been that for years attention has been largely directed to detecting unilateral renal disease in all cases of hypertension, whereas in fact, it does not account for more than about 1 per cent. of all cases.

Other workers, notably Goldring (1941) and his associates in New York have investigated renal function in detail by complicated tests designed to show the rate of glomerular filtration, the total renal blood flow and the maximum tubular excretory capacity. These tests were time-consuming and have not been used very widely. In the hands of the

originators, however, they seemed to show that there was no renal ischæmia in hypertensives. These tests were designed on the assumption that all blood flow through the kidney was by a single pathway. Recently, however, our conception of the renal circulation has been shaken by the work of Trueta, Barclay and others in Oxford (1947) who have given a convincing demonstration of an alternative vascular pathway. This alternative pathway had previously been postulated by Heggie (1941) but the results of his work remained unpublished.

These workers have shown that as a result of trauma (e.g., prolonged application of a tourniquet) the injection of staphylococcus toxin or splanchnic stimulation, the normal circulation through the kidney is altered and almost all the blood passes through a shorter path which leaves the whole cortex ischæmic. This shorter path is via the interlobular arteries, the juxta-medullary glomeruli, the vasa-recta and the interlobular arteries.

This demonstration explains many of the anomalies encountered by other workers using excretion tests and throws considerable doubt on the validity of the various clearance tests from which the effective renal blood flow was calculated. They have further shown that this renal " shunt " can be brought about in a number of ways, such as spasm of the afferent glomerular arterioles, obstruction of the cortical glomeruli by foreign substances or generalized vasodilatation such as that produced by prolonged inhalation of amyl nitrite, or by organic vascular change affecting the juxta-medullary glomeruli. Degeneration of these glomeruli occurs in advanced cases of hypertension and leaves a wide-open vascular path capable of taking progressively more blood from the rest of the renal circulation. This change, when it occurs, is permanent and irreversible.

The Oxford workers postulate that this mechanism of a vascular " shunt " in the kidney, which they have so effectively demonstrated, may be the means by which cortical ischæmia is produced in man and by which the vicious circle of renin production and its activation to hypertension, with consequent vascular spasm and further renal ischæmia, is started. This hypothesis cannot yet be proved. It is probable that renal " shunt " takes place many times during the day in response to various stimuli including emotional crises and one would therefore expect hypertension to be almost a physiological consequence of increasing age. Robinson and Brucer have indeed suggested that 40% of the population in the United States is actually hypertensive or pre-hypertensive. Furthermore, it has not yet been demonstrated whether angiotonin will of itself produce the renal vascular " shunt." Such a demonstration should be easy to prepare but so far as we are aware it has not yet been done.

We are making a particular study of one group of patients for we feel that it may be possible in this group to find the key to the problem of the mechanism of hypertension. The clinical picture of hypertensive

disease of pregnancy may be summarised briefly as a rising blood pressure usually appearing after the 20th week of pregnancy, albumin uria and retinal changes very similar to those of essential hypertension. The whole picture is indeed so similar that it is difficult to believe that the two are not closely allied. Golden, Dexter and Weiss (1943) in the United States have stated that 25% of all patients suffering from toxæmia of pregnancy develop permanent hypertension and that it is not the height of the blood pressure during pregnancy which matters, but the duration of the toxæmia. Barnes and Browne (1945), in this country, have denied the connection between the two and state that 25% of all toxæmias are due to a pre-existing hypertension which may be missed owing to the acceptance of too high a standard of normality. In support of this contention, they have analysed the blood pressure records of about 2,000 women attending a gynæcological department, and state that there is no significant difference between the blood pressure levels of parous and nulliparous women.

We feel that it is possible that both essential hypertension and specific hypertensive disease of pregnancy have a common origin in renal ischæmia and that it is the hereditary factor which makes the one permanent, while the other persists only throughout the pregnancy but frequently recurs in subsequent pregnancies. To put this theory to the proof, we have recently commenced a therapeutic test in the two groups of pregnant women—i.e. previously known hypertensives or those discovered before the 20th week and patients with pre-eclampsia or specific hypertensive disease of pregnancy which originates after the 20th week. It is known that a localised section of the splanchnic nerve such as that practised by Peet will, in early cases, produce a complete cure of hypertension. It has seemed to us improbable that this was due to a generalised splanchnic denervation and in view of the work on renal circulation, much more probable that section of the splanchnic nerve which in these cases has prevented continued renal cortical ischæmia. However, we have not yet felt justified in recommending a bilateral Peet operation in these women for a clinical experiment but have attempted to produce the same effect by para-vertebral alcohol injection. Such an injection is not easy. A temporary interruption of the nerve can be produced easily with novocain which diffuses widely through the tissues, but permanent or semi-permanent interruption will only occur if the tip of the needle is in contact with the sympathetic ganglion. All our injections have been controlled radiographically by injecting 3 minims of lipiodol immediately after 5 ccs. of alcohol, and unless the lipiodol was in contact with the heads of the ribs, the injection was considered to have been badly placed.

The results so far have been of interest, although the number of cases so treated has been very small and of no use for statistical purposes. We have found that with the bilateral injection from the 9th to the 12th dorsal ganglia the blood pressure in all cases falls considerably. In

most cases it rises afterwards and the immediate fall must be considered to be due to temporary paralysis of the splanchnic nerve by novocain. In one case, however, of specific hypertensive disease, the blood pressure fell steadily from the time of injection to a nearly normal level and with the resumption of activity in this patient the blood pressure fluctuated but did not resume its previous high level. It is obvious that this work must be continued before any conclusion can be drawn.

Further light on the relation of hypertension to pre-eclampsia is given by a consideration of a paper by Newell and Smithwick (1947). They reported 15 pregnancies in 14 patients who had been treated successfully for hypertension by splanchnicectomy. Half of these patients had been hypertensive before their first pregnancy, and in the pregnancy which followed splanchnicectomy the blood pressure rose slightly during pregnancy and subsequently fell to normal. In the remaining half of the patients, however, hypertension had not been present before the first pregnancy but was thought to have originated in pre-eclampsia. In these patients splanchnicectomy produced a cure of the hypertension and the blood pressure did not rise in a subsequent pregnancy. Cases of this type are as yet rare in this country but we have records of one silimar case operated upon by one of our colleagues. Thoraco-lumbar sympathectomy was performed for hypertension following pre-eclampsia. The result was very successful and the blood pressure fell to normal. In a subsequent pregnancy, there was no evidence of toxæmia and the blood pressure did not rise at all.

CLASSIFICATION OF PATIENTS

The classification of patients with high blood pressure is most important from the point of view of prognosis, but it is frequently far from easy. Cases of obvious endocrine disorder can readily be detected as can cases of renal disease where there is gross impairment of function, for it is known that essential hypertension only produces severe renal deficiency in about 8 per cent. of cases. In the later stages of essential hypertension it is indeed surprising how efficient is the renal excretory mechanism when we consider the amount of organic change which has taken place in the kidney.

Wagener and Keith, in the Mayo Clinic, advocated a classification into four groups depending on the degree of retinal change. This classification has been widely used and is easy to apply but unfortunately is of little use in case assessment. Severe retinal changes do not invariably indicate advanced disease, and advanced disease is not always accompanied by severe hypertensive retinopathy.

It is our view that a classification of patients should be both an indication of the severity of the disease and of the prognosis if treated surgically. Such a classification has been put forward by de Takats and Fowler and is as follows:

Group I   *Operable with a hope of cure.*   *Age :* Less than 40.

         Fundi : Within normal limits or silver wire arteries only.

         Blood pressure : Fluctuating; systolic 150/200; diastolic 100/120. May occasionally be normal at rest.

         Renal function : normal.

Group II   *Operable symptomatically but doubtful if curable. Age :* 20-55.

         Fundi : Retinal sclerosis and angiospasm. Occasional hæmorrhage.

         Blood pressure : Diastolic—never less than 110 even under pentothal.

         Renal function : Impaired but clearance at least 50 per cent. of normal.

Group III   *Not operable.*

         Blood pressure : High fixed diastolic.

         Heart : Angina or congestive failure often present.

         Renal function : Grossly impaired: maximum water concentration below 1015.

         C.N.S. : Hypertensive encephalopathic attacks and often permanent C.N.S. damage.

de Takats (1946) gave his results in cases in all three groups and found that all cases in *Group III* (10 in number) were dead within one year, while the results in both *Groups I and II* were eminently satisfactory from the patients' point of view.

This classification is useful and is the one generally used in this unit.

SELECTION OF PATIENTS FOR OPERATION

The selection of patients for operative treatment—i.e. sympathectomy, is not easy and widely differing standards have been used. de Takats (1946) makes a plea for a more rigid selection of patients, but we have felt that the results of surgical treatment in these cases are so uncertain and occasionally so unexpected, that the possibility of operative relief should not be denied to any but the most advanced cases. We feel that the indications and contra-indications can usefully be summarised as follows :

Indications

   1. Early cases of essential hypertension with a hope of cure, i.e. Group I.

   2. All cases following toxæmia of pregnancy.

   3. Late cases with incapacitating symptoms, i.e. Group II and some Group III cases. In the cases of Group III, the prognosis should be extremely guarded and we regard the following as absolute contra-indications :

Contra-Indications

   1. Mental changes indicative of cerebral vascular damage.

   2. Very diminished renal function (but not including cases with crises of oliguria) i.e. Group III.

In the investigation of our patients we employ, in addition to a full renal clinical examination, all the normal renal function tests, but not the insulin, diadiast and β-amino hipuric acid clearances advocated by Goldring and Homer Smith. We employ the pentothal and cold pressor tests to determine, if possible, the spastic element and, where the pentothal test has been inconclusive, we have on occasion injected the lower dorsal sympathetic chain and splanchnic nerves with novocain to determine the amount of postural hypotension which we may expect by operation. The final assessment however, must be a clinical one.

The rationale of splanchnicectomy may be stated briefly. Following the operation, lowering of blood pressure may be due to :

1. Increased circulation to the kidneys due to prevention of the renal vascular " shunt."
2. Dilation of the vascular bed in the splanchnic area and in the lower limbs which diminishes the periferal resistance and produces postural hypotension.
3. Denervation of the adrenal glands which prevents periodic rises in blood pressure and so prevents the periodic headaches and giddiness.

It is probable that only in the very early cases can the circulation to the kidneys be significantly increased, but in isolated instances an apparently advanced case with oliguria will show a fall in blood pressure and increased secretion of urine. In other cases, however, the immediate fall in blood pressure following the operation has been associated with anuria or oliguria and secretion has not returned to normal until the blood pressure has returned to its former level.

The dilatation of the periferal arteriolar bed probably plays an important part in the slight lowering of blood pressure which is a common result in these patients. It is to be noted that these patients suffer from varying degrees of postural hypotension post-operatively.

Denervation of the adrenal glands probably plays an important part in the relief of symptoms. The secretion of adrenaline occurs very largely in response to psychological stimulation, the nerve impulses passing to the adrenal gland through the least splanchnic nerve and possibly the rami connected with the first lumbar ganglion. When these fibres are divided, the blood pressure, even if it remains high, does not fluctuate.

PROGNOSIS

The number of patients with essential hypertension treated by us is quite small, namely—20 by thoraco-lumbar splanchnicectomy and 16 by supradiaphragmatic splanchnicectomy, and therefore we do not propose to analyse in detail our results. Such studies have been made by many other workers on larger series, and Grimson (1947) has recently summarised the results of 950 reported cases.

We have divided the cases into four groups—cure, good result, fair result and poor result, as follows :

TABLE I

RESULTS OF SPLANCHNICECTOMY

	Cases	Cure	Good result	Fair result	Poor result	Operative deaths	Operations not completed	Too recent to be of value
Supradiaphragmatic								
Male	8	0	3	1	2	0	2	0
Female	9	2	2	3	1	1	0	0
Thoraco-lumbar								
Male	5	0	2	0	0	1	1	1
Female	15	2	2	1	1	0	5	4

NOTES : Cure : Complete symptomatic relief and blood pressure normal.
Good results : Complete symptomatic relief; blood pressure unchanged or reduced but diastolic still over 100.
Fair result : Partial symptomatic relief; blood pressure usually unchanged. Patient satisfied that operation has been worth while.

It is of interest to note, that of the cases reported cured, all are women, and in all of them the disease was believed to follow specific hypertensive disease of pregnancy. Their ages were—33, 23, and 39. In one of these cases the hypertension was known to have been present for 9 years. One other case in Group A commenced as specific hypertensive disease but unfortunately she died shortly after operation apparently from cerebral thrombosis.

We feel that while the chances of cure are low, unless very early cases are treated, the prospect of symptomatic relief is extremely high and life, if not lengthened, is at least made bearable. Our medical colleagues agree with us in this and refer many patients to us for a surgical opinion.

OPERATIVE TREATMENT

The earliest operations on the sympathetic system were very limited in scope. Pieri first reported an operation for section of the splanchnic nerve in 1927. Peet in 1925 published the results of the same operation which he had been practising for two years. The operation was supradiaphragmatic, entirely preganglionic in character, and had the great advantage that both sides could be operated upon at the same time. With the patient lying prone, a length of the 11th rib and transverse proscess was resected on each side and the ganglionic chain resected from the 10th to the 12th thoracic ganglia inclusive. A length of the great splanchnic nerve was also resected. In a review of his cases in 1940, Peet, Woods and Braden show that the results of the operation may be permanent for in some cases the follow-up period extends to seven years.

Sub-diaphragmatic splanchnicectomy was developed by Craig (1934) at the Mayo clinic. The splanchnic bed was denervated by a sub-diaphragmatic section of the great splanchnic nerves, resection of part of the cœliac ganglion on each side and resection of the first and second lumbar ganglia. The operation was performed in two stages. The results of the operation appear to be less favourable than those of the Peet operation and it has been very largely abandoned.

Cœliac ganglionectomy as practised by Crile (1937), consisted of excision of both cœliac ganglion with division of the greater and lesser splanchnic nerves below the diaphragm. His operation was done in one stage and the mortality was low. The operation was followed by considerable symptomatic relief and in Crile's view the expectation of life of the patient was increased. The operation however, is post-ganglionic and physiologically unsound. In our very small experience of this operation in the Professorial Unit in Liverpool, the operation was followed by severe vomiting apparently as a result of pylorospasm.

In an attempt to produce a more complete denervation which would be pre-ganglionic and hence both physiological and permanent in its effect, the more extensive trans-diaphragmatic thoraco-lumbar sympathectomy was introduced by Smithwick of Massachusetts (1940). In this operation, the sympathetic chain was removed from the ninth thoracic to the second lumbar ganglia together with the great, lesser and least splanchnic nerves. Various positions and approaches have been used for this procedure. Smithwick favoured the prone position, de Takats and many others, the lateral. We use the lateral position and recently have used a modified Fey's incision.

This incision is placed farther forward than the other renal incisions and was designed by Fey to give access to the upper pole of the kidney. Through this incision, access is considerably improved and it is possible to visualise the whole of the operative field at the same time.

As a result of this improved access, it has been found possible to remove the sympathetic chain and splanchnic nerves in continuity. This is probably an unnecessary refinement but is evidence of good access and leaves no uncertainty about the completeness of the operation.

We do not know whether other workers have also found this approach independently but there is, at the present time, no published account of its application to thoraco-lumbar sympathectomy.

OPERATIVE TECHNIQUE

The patient is placed on his side with a very slight backward tilt. The backward tilt is not important but any degree of forward tilt should be avoided. The 11th rib is palpated after inspection of the X-ray film and the line of incision marked. This commences at the lateral edge of erector spinæ, passes along the 11th rib to its tip and then angles downwards to a point a little in front of the anterior superior spine. The incision is deepened to the rib and the periostium stripped from the anterior surface. The rib is depressed and the digitation of the diaphragm arising from its tip is divided with a knife. The anterior part of the incision is deepened by separating the fibres of external oblique and dividing those of the internal oblique and transversus abdominis. The approach is less traumatising than the standard kidney incisions. The peritoneum and the kidney within its fascia are displaced forwards. The pleura which is seen in the upper and posterior part of the wound is gently
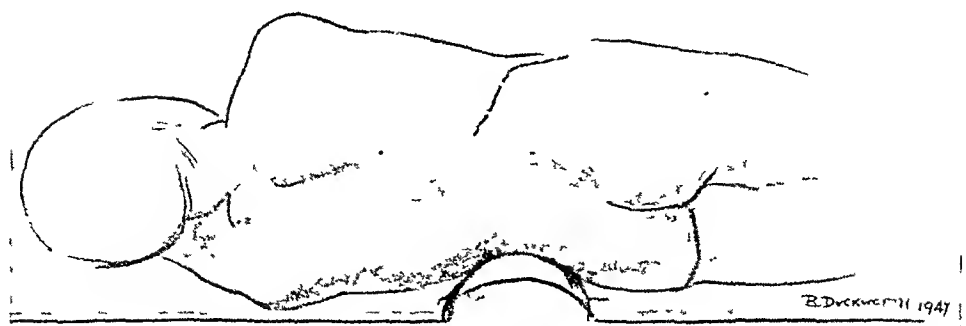
Fig. 6. The extended Fey incision.
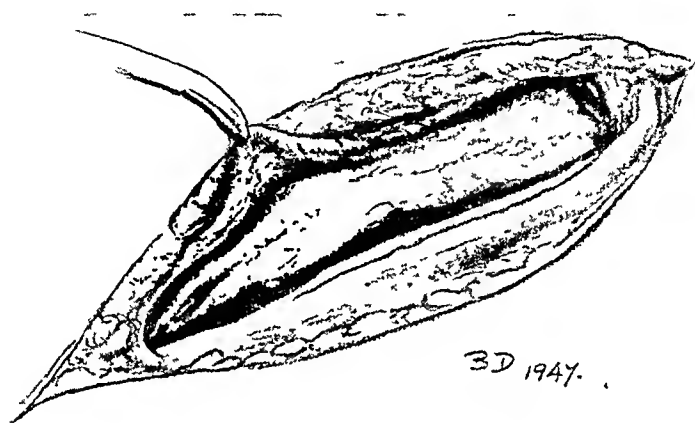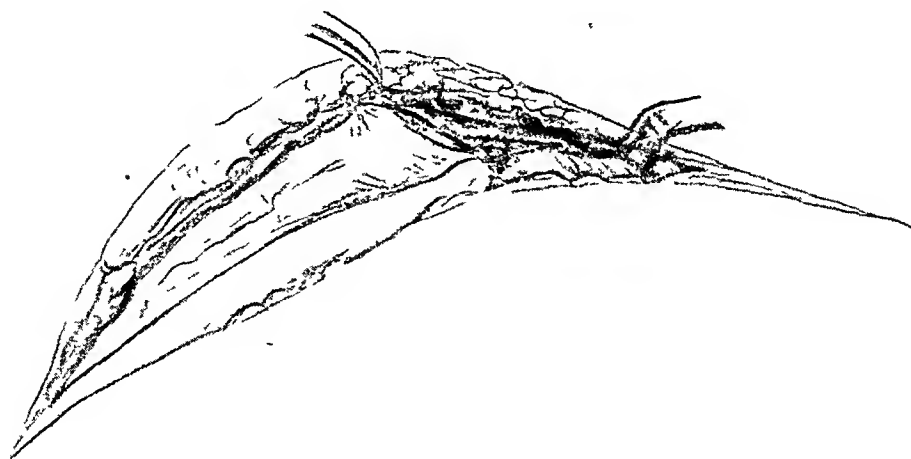

Fig. 7. The posterior end of the incision.

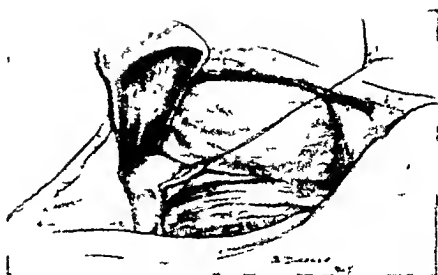Fig. 8. The completed incision.

Fig. 9.   The great splanchnic nerve.
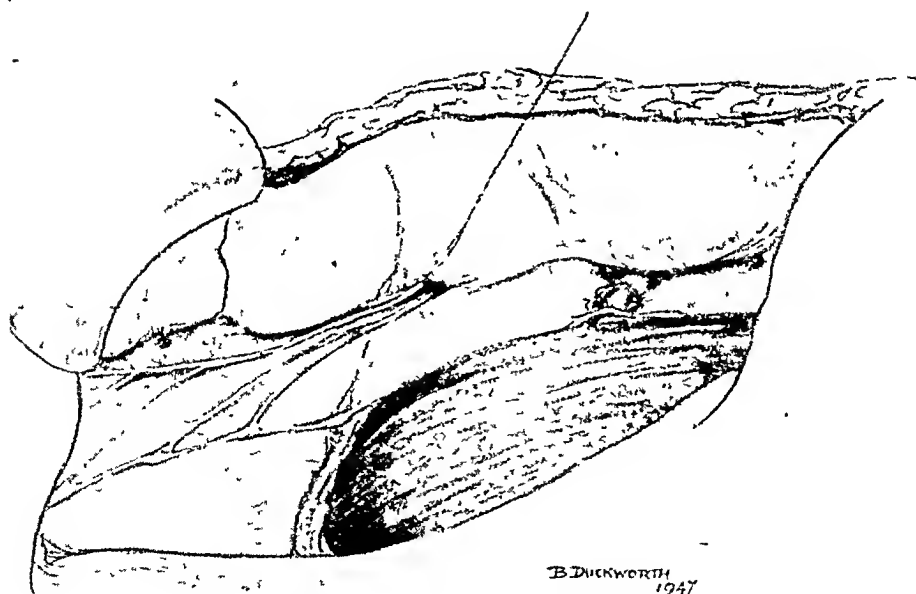
Fig. 10.   The diaphragm divided.

B.Duckworth
1947

Fig. 11.   The complete dissection.

displaced backwards and a finger insinuated above the diaphragm at the tip of the 11th rib and pushed round the chest wall towards the crus, displacing the pleura on the way. The diaphragm is then incised as far as the crus where it is perforated by the great splanchnic nerve. The pleura is then carefully dissected from the chest wall in the plane of the great splanchnic nerve, care being taken to keep if possible in the extra fascial plane and avoid opening the pleura. This stripping is carried upwards to the level of the eighth thoracic ganglion or higher, when the fibres from the chain which are from the great splanchnic nerve can be visualised. The thoracic chain is traced beneath the medial arcuate ligament into the lumbar chain. Not until the whole of this is visualised is any attempt made to resect any nerves.

In the course of the dissection it will be noticed that in the region of the medial arcuate ligament there is a sharp bend in the sympathetic chain as it changes from its thoracic position over the heads of the ribs to its lumbar position on the autero-lateral aspect of the vertebral body. This change in direction may be misleading. After the resection is completed, the wound is closed in layers, without drainage.

The difficulties of the operation are those of inadequate access but have been largely removed by a new approach. Injury to the pleura is still not uncommon but can in many cases be avoided by stripping in the extra fascial plane.

The complications of the operation are:

1. *Pneumothorax and collapse of the lung.* If a pneumothorax occurs during the operation, the wound should be closed round a catheter placed in the pleural opening and the lung inflated at the end of the operation, when the catheter can be removed. An X-ray examination should be made next day and if a large pneumothorax is present, the air should be removed.

The importance of adequately controlled ventilation while the chest is open cannot be over-emphasised.

2. *Surgical emphysema.* This only occurs in cases where hæmostasis has been inadequate and a drainage tube is used; surgical emphysema should not occur.

3. *Cerebral thrombosis.* Occasionally occurs under anæsthesia and may prove fatal. In one of our cases there was thrombosis of the central artery of the retina during the course of the operation.

4. *Anuria.* May occur occasionally as a result of a severe fall in blood pressure. We have seen it in one case only. Recovery occurred after a few days when the blood pressure rose to its former level. This patient is one of those experiencing complete symptomatic relief.

Although the original Smithwick type of thoraco-lumbar sympathectomy is probably the most widely practised at the present time, more and more extensive operations are being introduced. The most extensive of these so far has been bilateral removal of the sympathetic chain between the first thoracic and third or fourth lumbar ganglia inclusive (Grimson 1941).

It has been recently said by Grimson (1942) that "in general, the extent of the fall in blood pressure is directly proportional to the extent of the sympathectomy and inversely proportional to the severity of the disease." The greater the extent of the sympathectomy however, the more undesirable will be the side effects introduced, and after a total and bilateral thoraco-lumbar sympathectomy sweating will be abolished over the whole body surface, a condition which might well have a disastrous effect on the heat regulation mechanism of the body.

CONCLUSION

Surgical treatment of essential hypertension holds out the only hope of a lasting cure for the disease. Even then a cure can only be obtained in the early stages and in certain advanced cases which are at present unidentifiable. A considerable drop in blood pressure can often be obtained by extensive sympathectomy, but a limited sympathectomy such as the Peet operation should be adequate to prevent the renal vascular " shunt," and consequent cortical ischæmia which is thought to be responsible for the maintenance of hypertension. It would seem that the direction of advance should be in obtaining cases sufficiently early to allow such a very limited sympathectomy to be effective or, alternatively, in recognising those advanced cases in which, because of a pronounced spastic element or a definite œtiological factor, there is hope of cure. The pentothal test gives no information of value in this latter group. It seems to us, however, that cases which are first recognised in pregnancy as preclampsia have a particularly favourable prognosis.

In the late stages of the disease, relief can be given for the more distressing symptoms and if life is not prolonged it is at least made more comfortable and in many instances a patient previously incapacitated has been able to resume full work.

In conclusion, one may quote from de Takat's paper (1946), that " so far no single or combined method of treatment can be recognised which would give rigidly selected patients with hypertension as much benefit as trans-diaphragmatic splanchnic nerve section combined with dorso-lumbar sympathetic ganglionectomy."

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THE RESTORATION AND DEVELOPMENT FUND.

The Restoration Fund has now reached nearly £192,000. It is hoped that the response to an appeal which will be sent on the anniversary of Hunter's birth, to those Fellows who have not yet subscribed, will bring the total to £200,000 soon after February 14th, 1949.

Notable gifts since the last report include one hundred guineas from Mr. Julian Taylor, and from Mr. R. E. Pleasance, and a second donation of one hundred pounds from Mrs. S. G. Asher (per The President). Another most gratifying gift was from Professor Rienhoff, who presented the fee for his Moynihan Lecture to the Restoration Fund.

THE INTERPRETATION OF VISCERAL PAIN

Lecture delivered at the Royal College of Surgeons of England
on
6th October, 1948
by
F. H. Bentley, O.B.E., F.R.C.S.
Professor of Surgery, University of Durham

THE SUBJECT OF visceral pain arouses much controversy, for whenever knowledge is deficient, argument and hypothesis flourish. It is the purpose of this lecture to survey some aspects of abdominal pain, to take stock of what we know, what can be concluded and what may be conjectured ; and to illustrate our knowledge with some common examples of visceral pain.

THE ANATOMICAL PATHWAY FOR VISCERAL PAIN

Stimulus.—The hollow viscera such as the bowel, renal pelvis or bile ducts are sensitive to the stimulus of tension or distension. The best clinical example is intestinal colic, in which spasmodic cramp-like pain results from excessive contraction of the smooth muscle of the bowel wall. Experimentally, a similar pain can be produced by distension of the small intestine with a balloon, or of the colon with an enema.

Whereas the hollow viscera are not sensitive to stimuli such as cutting or burning, the mesentery is acutely sensitive to mechanical stimulation. Observations made at operations performed under local anæsthesia of the abdominal wall show that pain occurs when the mesentery is touched, cut, pulled upon or injected with an irritant chemical. The sensitivity begins abruptly at the mesenteric border of the gut, and extends to the posterior abdominal wall.

In addition to pain arising from spasm of smooth muscle or from stimulation of the mesentery, there is some evidence that an inflammatory process in a viscus may give rise to pain, and also cause the viscus to become tender on pressure. Certainly this is true of the ulcerated stomach wall, for if at operation under local anæsthesia an ulcer mass in the anterior wall of the stomach is touched or pricked or injected with an irritant chemical, pain is produced which the patient describes as similar to his ulcer pain. The non-ulcerated stomach wall is not sensitive to these stimuli. This is a provocative finding, and investigation of the conditions that are responsible for the alteration in sensitivity to painful stimuli may provide a new outlook on pain production in general.

The Pathway.—The fibres which conduct pain impulses from the abdominal viscera are similar to somatic afferent fibres, in that they are myelinated and have their cell stations in the posterior root ganglia. They run, however, in the splanchnic nerves, passing without interruption through the sympathetic ganglia to reach the cord.

The proof of the passage of these pain fibres by the splanchnic nerves is certain.

  (i) If a balloon is distended in the small intestine pain is felt across the centre of the abdomen above the umbilicus. If this is repeated after both splanchnic nerves have been cut (as in the operation for hypertension) no pain occurs on distension of the balloon.

  (ii) The pain of a peptic ulcer and the epigastric tenderness on pressure are abolished by paravertebral injection of the splanchnic nerves with procaine.

  (iii) In patients in whom bilateral splanchnic section has been performed for hypertension it is impossible to produce pain by traction or mechanical stimulation of any part of the mesentery. The intercostal nerves are thus not concerned in the sensitivity of the mesentery.

It can be concluded, therefore, that whatever other causes of visceral pain may still be demonstrated, it is at least clear that pain can arise from tension in a hollow viscus, from mechanical stimulation of the mesentery, and from an ulcerative process within the stomach or duodenum. The pain fibres from these sources pass from the abdomen by the splanchnic nerves to reach the cord.

IS VISCERAL PAIN A SEPARATE ENTITY ?

Pain is ordinarily classified as cutaneous, deep somatic and visceral. Cutaneous pain arises from mechanical stimulation and has a characteristic sharp quality and accurate localisation. Deep somatic pain, as from a closed fracture, muscle cramp or ischæmia of muscle, is duller in quality, is felt to be deeply within the limb, and is not so well localised. Visceral pain, such as colic or from a peptic ulcer, also has a dull, rather diffuse quality, and is poorly localised.

There is no doubt that visceral pain exists, and some have maintained that it is a separate physiological entity, distinct from and having no association with other forms of pain. Lewis argued, however, that deep somatic pain and visceral pain were similar, and recognised only two main types of pain ; cutaneous pain with one set of qualities, and deep pain, whether somatic or visceral, with another.

It is not an important practical question, but until we know more of pain mechanisms it is probably better to keep to the simpler view.

LOCALISATION OF VISCERAL PAIN

No other aspect of the subject has aroused so much debate as the question, "where is visceral pain felt?" It is felt, of course, in the sensorium ; but what is really meant is, where does the pain appear to be to the patient ; that is, to what position is it localised ?

The contemporary view is based on the teaching of Mackenzie and Head who held that afferent pain impulses from the viscus set up an irritable focus in the spinal cord, which spreads to somatic neurones, so giving rise to an apparent localisation of the pain to the skin area. By this

viscero-sensory radiation pain in superficial structures remote from the disease site is accounted for. Tenderness to touch is ascribed to impulses which ordinarily would be below the threshold for pain arriving in the segment rendered super-excitable by the irritable focus. It is inherent in this view that the area of pain and tenderness in the abdominal wall remains fixed, though the position of the diseased viscus changes.

The belief that all visceral pain is localised to the site of the corresponding dermatome has many advocates, but it is not in accordance with all the facts.

In the first place, when one experiences intestinal colic and considers carefully just where the pain feels to be, it is evident that it is a deep pain and not on the surface. Nor is the pain of intestinal colic or of peptic ulcer segmental. It is in the middle line anteriorly, and if there is any back pain (and this is rare) a pain-free gap exists laterally.

Furthermore, the area of pain and tenderness in visceral disease is not fixed, but does in fact vary with the situation of the diseased organ. Thus the pain of a peptic ulcer is in the epigastrium, but if a stomal ulcer should follow gastro-enterostomy, the new pain is to the left of the umbilicus, that is towards the place where the new ulcer is situated.

Evidence that the localisation of visceral pain is not dependent upon afferent impulses passing up from the skin is found in patients with a complete transection of the cord resulting in complete anæsthesia of the abdominal wall. In such patients abdominal colic is well appreciated in the centre of the abdomen.

An interesting experiment demonstrated recently by Mr. F. R. Browne at a meeting of surgeons in Dundee, is further evidence against the radiation of visceral pain to a skin area. A hydrocele of the tunica vaginalis was tapped through an anæsthetised weal of scrotal skin, and the sensitive tunica anæsthetised by injecting into the sac about 20 ml. of 1 per cent. procaine. The tunica vaginalis was now insensitive but the sensitivity of the body of the testis was unimpaired. Squeezing of the testis or pricking with the injection needle caused a well marked pain low down in the iliac fossa, considerably below the dermatome of T.10 which is the testicular segmental supply.

Experiments with local anæsthesia on patients suffering from visceral pain have appeared to confirm the Mackenzie view of viscero-sensory radiation. In these experiments the area of abdominal wall over which the pain is felt is infiltrated subcutaneously with a solution of procaine so as to produce anæsthesia of this part of the abdominal skin. Many investiga- tors have reported diminution or abolition of the pain following the injec- tion. These observations are to be accepted with caution, for all experi- ments with procaine on pain phenomena are open to suspicion. Many factors other than skin anæsthesia are concerned in the results, and even if the observation that subcutaneous injection of procaine diminished visceral pain was correct, it would still require much further elucidation

before it could be concluded that the reduction of pain was due to the anæsthesia. In the event, however, the observation may not be correct, as the following examples show:

It was claimed that the visceral pain of the first stage of labour was abolished by local anæsthesia of the abdominal wall. To test this claim is simple. It is necessary to anæsthetise only the right or left half of the abdominal wall, and observe if the pain is now unilateral. When this is done, however, it is found that the patient's emotional condition during childbirth completely prevents her giving answers that will satisfy a critical enquirer. The pain may or may not be modified; it is impossible to say.

In a patient admitted with an impacted inguinal hernia, it was possible to produce severe pain in the epigastrium by squeezing the scrotal swelling. After anæsthetising the skin area in the region where the pain was most severe, the pain was now said to be in a different part of the abdominal wall, and again the localisation moved when this further area was anæsthetised. Finally, after subcutaneous injection of the anterior abdominal and chest wall from umbilicus to nipple line, during which a total of 1·5 grammes of procaine were injected, all pain disappeared, however firmly the contents of the scrotum were squeezed. Two hours later, full sensation returned to the skin but pain on squeezing the scrotal swelling did not return. Although the patient was kept under observation for three more days, central pain on squeezing the hernia did not recur.

Many other examples could be described in which subcutaneous injection of procaine modified or abolished a visceral pain, but return of skin sensation was not accompanied by return of pain, although the disease process remained constant.

It is fair to conclude that although a viscero-sensory radiation of abdominal pain cannot yet be disproved, the conception is of doubtful validity.

A simpler view of the localisation of visceral pain, and one not in conflict with any established observations, is that visceral pain, like all deep pain, is vaguely localised to the part of the body where the disease exists. In so far as there is little or no education of the sensorium about the localisation of disease processes in deep tissues, it is not surprising that localisation is not more precise, and this gives point to the suggestion of Browne that the brain localises deep pain to the embryological position of the viscus. There is, of course, some degree of localisation of visceral pain. Thus pain arising from colic of the upper small intestine is felt to be above the umbilicus, from the lower small intestine the pain is in the region of the umbilicus, and from the large bowel in the hypogastrium. The pain from spasm of the Fallopian tube is localised across the pubis, whereas biliary colic is felt to be across the upper abdomen, more severely on the right than the left. The localisation of testicular pain has already been described.

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All that may safely be concluded is that visceral pain exists and is poorly localised ; it is better to consider it in this simple way rather than evoke complicated sensory mechanisms until at least we have further precise evidence.

PAIN FROM THE PARIETAL PERITONEUM

It is not possible to consider the problem of the interpretation of visceral pain without including the pain that arises from stimulation of the parietal peritoneum. The role of the parietal peritoneum in abdominal pain has been clarified and defined by Morley, and it is now generally recognised that the parietal peritoneum is acutely sensitive to mechanical and chemical stimulation. Such stimulation gives rise to sharp, well localised, pain, and severe stimulation sets up rigidity of the overlying abdominal muscles. There is no further need to stress this pain mechanism or its significance in the production of abdominal symptoms and signs.

VISCERO-MOTOR REFLEXES

Although it is well recognised that rigidity of the abdominal muscles follows irritation of the parietal peritoneum, it is still a matter for debate whether abdominal rigidity follows purely visceral disease without stimulation of the sensitive parietal peritoneum. The vexed argument continues probably because the same conditions do not apply to all the abdominal viscera. Thus, even in the most severe intestinal colic, there is no rigidity of the abdominal musculature. On the other hand renal colic is commonly accompanied by rigidity of the muscles of the loin. It is doubtful whether biliary colic, without inflammatory changes in the wall of the gall-bladder, is accompanied by true involuntary rigidity. The impression obtained on examining patients suffering from biliary colic, and in whom there is no reason to suspect cholecystitis, is that the resistance of the abdominal wall is a voluntary guarding of a painful area rather than an involuntary rigidity such as occurs in peritonitis. Similarly, in patients who present muscle guarding in the epigastrium during an exacerbation of a peptic ulcer, the ulcer is not infrequently found at operation to be completely shut off from the anterior abdominal wall, as by a large adherent liver, so that it appears impossible for the ulcer to have stimulated the anterior parietal peritoneum. It is often difficult to tell whether the upper recti are in a condition of true involuntary rigidity, or if the resistance of the muscle is merely part of the natural desire of the patient to protect a painful area. The ulcerated wall of stomach or duodenum is itself tender ; pressure therefore in the epigastrium will increase the pain. In consequence, it is reasonable to suppose that the patient will be ready to guard against the pressure of the examiner's hand.

For reasons such as these, it is difficult to know whether biliary colic and peptic ulcer pain are accompanied by rigidity or not. It is better therefore to conclude that whereas in intestinal colic there is no question of a viscero-motor reflex, such a reflex is to be expected in renal colic ;

the occurrence of abdominal wall rigidity in other purely visceral lesions is at present doubtful. It should be emphasised, however, that apart from renal colic, the presence of involuntary rigidity in the abdominal wall should arouse the most urgent suspicions of a lesion producing irritation of the parietal peritoneum.

ILLUSTRATIONS

So far an attempt has been made to clarify certain aspects of visceral pain. Some common examples of abdominal disorder will help to illustrate our knowledge.

Acute Obstructive Appendicitis.—At the onset a concretion is impacted in the appendix, and appendicular colic is set up. This is felt as typical small bowel pain, each colicy spasm being localised across the centre of the abdomen, and lasting half a minute or so. At this stage there is nothing to distinguish between this appendicular pain and small bowel colic from any other cause. Equally, there are no abnormal physical signs.

A little later as acute inflammation begins, the occluded part of the appendix is distended with inflammatory exudate. The continuous tension sets up a constant pain which, since it arises from the appendix, is still localised across the centre of the abdomen. The inflammatory changes are as yet within the appendix and there are no abnormal physical signs.

As the acute inflammatory process continues to spread it reaches the surface of the appendix and begins to irritate the adjacent parietal peritoneum. The patient is now conscious not only of a constant dull pain across the abdomen from tension within the appendix, but also of a sharp well localised pain in the right lower abdomen. At the same time local abdominal tenderness begins.

If now the appendix perforates, the tension within the appendix is relieved and the central pain is abolished; the patient continues to feel a well localised pain in the right iliac fossa which spreads as the peritoneal inflammation extends. Abdominal rigidity is now discovered, beginning in the area where the peritoneal irritation is most marked. Local tenderness and rigidity continue to keep pace with the inflammatory process within the peritoneal cavity.

The situation of maximum tenderness and rigidity in patients suffering from acute appendicitis is well recognised by surgeons as a guide in placing the incision, since it is likely that the appendix is lying near to the site of maximal peritoneal irritation.

Biliary Colic and Cholecystitis.—In biliary colic the spasms of pain are more continuous than in intestinal colic, giving rise to deep-seated severe griping pain felt by the patient to be across the upper abdomen and in the right hypochondrium, sometimes going through to the back in the region of the angle of the right scapula. The severe pain lasts some hours, and as it is visceral in origin it never achieves accurate localisation.

While the stone remains impacted in the neck of the gall-bladder or bile duct the pain maintains this diffuse ill localised character. As inflammatory changes develop within the obstructed gall-bladder and the gall-bladder is increasingly distended, the pain becomes even more severe and continuous. It is only, however, when inflammatory changes spread through the wall of the gall-bladder to reach the adjacent parietal peritoneum, that the pain becomes well localised to the right hypochondrium and there is obvious local tenderness. There may be muscle-guarding in this area before inflammatory changes develop, but true involuntary rigidity in the right upper abdomen only occurs when the inflammation irritates the parietal peritoneum. The extent of local tenderness and rigidity can therefore be used as a reliable guide to the spread of the inflammatory process in the upper abdomen, so much so that when the patient is first seen it is customary to mark out on the skin the area of acute tenderness and rigidity. If this area continues to increase, it is an important indication to take into account, together with the temperature, pulse and general condition, in deciding whether the inflammatory process is spreading dangerously and operation should be performed.

Intestinal Colic.—The pain of intestinal colic is characterised by the frequent short spasms, each pain rising to a maximum, lasting a few seconds or half a minute, and dying away. The localisation of the pain indicates which part of the alimentary canal is affected. There are no abnormal physical signs in the abdomen, and from the pain it is not possible to know whether the colic is due to a dietary indiscretion or to a mechanical obstruction of the appendix or intestinal canal. All patients therefore, and particularly children, with intestinal colic are carefully watched for the physical signs that indicate inflammatory mischief, and morphia is withheld until a diagnosis is certain. If the spasms of pain continue regularly and urgently and signs of irritation of the parietal peritoneum do not develop, then they afford, in the absence of obvious symptoms such as the diarrhoea and vomiting of enteritis, strong presumptive evidence of a mechanical obstruction. The best example of this is an acute intussusception, in which the most striking feature is the clearcut spasms of pain recurring at intervals, while between the bouts the child is tranquil and pale. The continuation of urgent spasms of intestinal colic is thus in itself sufficient to raise strong suspicions of a mechanical block, without consideration of such factors as vomiting, distension or absence of flatus on which the diagnosis will finally depend.

Renal Colic.—In renal colic the pain is well localised to the affected loin. In fact, the sharp localisation often raises a suspicion of peritoneal irritation, as when perforation of a duodenal ulcer permits the stomach contents to track down the right para-colic gutter. This suspicion is reinforced when rigidity of the anterior loin muscles is found. It must be clearly recognised that the distribution of the pain and the condition of the abdominal muscles cannot safely be used to distinguish between right renal colic and inflammatory mischief in the right side of the peritoneal

cavity. There are of course other aids to diagnosis, such as the restlessness of the patient with colic and the restrained movements of the patient with intraperitoneal inflammation ; the tendency for renal colic to be spasmodic, and the strictly right sided distribution of renal pain. Even so, in a suspected case of renal colic it is sometimes a most anxious decision whether to give morphia or to withhold it. When in doubt, the only safe practice is to continue observation ; if the pain and rigidity are due to peritoneal irritation the progressive nature of the physical signs within a few hours will indicate the need for operation.

THE BUCKSTON BROWNE DINNER

THE BUCKSTON BROWNE Annual Dinner was held on Thursday, November 11, when 126 Fellows and Members dined together in the Library with Lord Webb-Johnson presiding.

After dinner Professor E. D. Churchill, John Homans Professor of Surgery at Harvard University, was admitted to the Honorary Fellowship. He was presented by Mr. L. E. C. Norbury, senior Vice-President, and the President handed him his diploma with the customary words of admission : " In the name of the Royal College of Surgeons of England, and by the authority of the Council I hereby admit you as a Fellow of the College, *honoris causa*." Professor Churchill expressed his thanks to the College for the honour conferred on him, and also his appreciation of the spirit of Buckston Browne and the friendliness inspired by such occasions as the present.

Lord Webb-Johnson mentioned some of the recent activities of the College, especially the remarkable growth of post-graduate education, and spoke of the decision of the Council to establish a residential College with full collegiate amenities, which would be of great assistance to graduates from overseas and link them more closely with the College.

Mr. L. E. C. Norbury proposed the health of " The Guests," welcoming in particular Professor Churchill, Lord Stamp, Sir Wilson Jameson, and the Directors-General of the Services.

Sir Wilson Jameson paid a warm tribute to the work of the College in the field of post-graduate education, in which the Minister of Health was much interested. Officials of the Ministry were always ready to give assistance to the College, but this was generally rendered unnecessary by effective action on the part of the President.

The Museum was open after dinner and the plans for the new buildings were on view.

HOMER'S FIGHTING SURGEONS
MACHAON AND PODALIRIUS

by

S. Wood
Library Assistant, Royal College of Surgeons

" WAR IS THE surgeons' school and he who would practise surgery must go to war." Thus said Hippocrates 23 centuries ago and if his saying is true there must be an abundance of surgeons who increased their knowledge and skill in the two major wars of our generation. The badge they wore linked them with Æsculapius, the God of Medicine, whose sons, Machaon and Podalirius, were surgeons and " valiant warriors " who likewise gained experience of battle wounds on the plains of Troy during a war of 10 years' duration.

In Greek sculpture Æsculapius is first revealed as a god, and in the form of a snake(1) was brought from Thessaly to subdue a plague in Rome. The coils were so monstrous that the ship was weighed down by the burden but having duly arrived in port the plague was eliminated with god-like efficiency and the snake returned whence he came. He is next seen as an old gentleman leaning on a staff accompanied by a huge snake ; in the third representation the snake is diminutive and coiled round the staff, and finally the old man has the field all to himself; both snake and staff have vanished.

These sculptures demonstrate four stages in the descent of a god and now he must be given parents in order to fit naturally into the story. So it follows that Æsculapius was born where his mother, Coronis, happened to be at the time, his father being Apollo, the god of music, archery and healing. But even in those ancient times the " eternal triangle " was not unknown, for while Coronis was pregnant by the god she was intimate with a handsome young sprig named Ischys. A tale-bearing white crow informed Apollo of these goings-on and he slew his wife and turned the crow black, which accounts for the colour of that bird to this day. But as Coronis lay on the funeral pyre Apollo, regretting the destruction of his offspring, opened her body and delivered the child by a pre-Cæsar Cæsarean section. Intriguing thought—that Medicine owes her very existence to Surgery !

Having thus brought Æsculapius down to earth where he is needed to become the father of Machaon and Podalirius we leave the firm ground of mythology where anything may happen and even the gods can be made to dance like puppets on a string without some busybody asking for one's " authority." On the shifting sands of history one of the first people we meet is Homer whose *Iliad* gives us a glimpse of Greek medical practice 3,000 years ago when the Trojan War afforded material for his story. When a nation is ripe for war it is necessary, in order to begin hostilities with a clear conscience, that an " incident " should be arranged and in this case it was the abduction of the unresisting Helen of Troy which led to a long and bloody war and inspired the *Iliad*. Thanks be to Helen !

Machaon and Podalirius, says Homer, were the chief medical officers attached to the Greek forces which set out from Thessaly to the siege of Troy (2). Although officially exempt from the dangers of battle they were doughty fighters as well as surgeons and had command of a crowd of toughs, 30 shiploads of them, drawn from Tricca and " from Ithome rough and rude with rocks and glens." The brothers were endowed with precious gifts and are called by Homer " healers of all disease " but they were powerless against the plague which attacked the Greek troops and which is so well described at the opening of the story. Unfortunately, there is little record of the brothers' personal work save the extracting of arrow and spear-heads, checking hæmorrhage by styptics, and the applying of soothing preparations to wounded and bruised surfaces, but various descriptions indicate the nature of the injuries they would encounter. Spear wounds were common and often fatal. When Pandaros was struck by Diomedes the spear entered his nose beside the eye, pierced his white teeth and cut through the root of his tongue causing him to fall dead from his chariot. Archelochos was struck in the chest and his struggling heart shook the point of the spear until he died.

Abdominal wounds were regarded as specially dangerous. Hygsenor was wounded in the liver below the diaphragm and his two comrades stooping down, carried him away to the ships groaning deeply. Adamas was struck in the lower abdomen and " he gasped a little but not for long." Great stones were hurled about by catapults and when one of these wounded Hector in the chest, he fell as though struck by lightning. His friends poured water over him and he sat up but spat out dark blood and again sank back senseless, oppressed by a grievous panting.

Wounds of the extremities were seldom fatal. Agamemnon, injured in the hand, went on fighting and killed many while the blood continued to flow but when the wound dried, sharp pains afflicted him. There are two cases of sword wounds where the arm was severed from the body.

MACHAON IN ACTION

An urgent call goes out for Machaon when Menelaus is wounded in the side by an arrow. He hastens to his patient who is surrounded and pressed upon in the manner of to-day by a crowd of select people and in view of this formidable audience of chiefs, Machaon proceeds to demonstrate his skill upon the unfortunate Menelaus. At once he drew out the arrow but so forcibly that the barbs were bent (3) ; one translation says the barbs were broken off in the wound which was then spread over with " drugs of balmy power." This could hardly be so ; an arrow does not part with its barbs so easily and Machaon, the Surgeon-General, would not heal the tissues over foreign bodies—unless he had in mind the performance of a two-stage operation !

On the Arms of this College, where Machaon and Podalirius are the supporters, the arrow is shown broken in the shaft, which does not agree with any translation.

While fighting valiantly Machaon was himself wounded by an arrow which pierced his right shoulder to the great dismay of the Greeks who fought furiously around him so that he should not be taken and killed by the enemy. Nestor is called upon to take the injured man into his chariot and with all speed bear him out of the battle to a place of safety. Interest in Machaon's wound extends even to the great Achilles who said, " Verily from behind he is like Machaon, but I beheld not the eyes of the man, for the horses sped past me, straining forward eagerly." Patroclus is thereupon sent hot-foot to ascertain the truth.

The chariot arrives at Nestor's tent where the blonde Hekamede, " a nymph of form divine " ministers to them. After making them comfortable on soft couches she mixed in a noble cup Pramnian wine, grated cheese of goats' milk, sprinkled over with meal(4) and with this draught they slaked their fiery thirst and sat in friendly discourse.

Machaon's wound was evidently not serious for Patroclus did not help as he would have done in a case of urgency, since on another occasion he skilfully treated Eurypylus by enlarging a wound with his knife to release an embedded weapon. Neither was the garrulous Nestor perturbed ; he told his long stories and then, becoming uneasy at the increasing noise of battle, went off to an observation post after advising Machaon to relax in Hekamede's care—excellent advice which could scarcely have been improved by Machaon himself. The patient made a good recovery and lived to fight another day, but at last came to a warrior's end.

THE DEATH OF MACHAON

There is the usual conflict of opinion regarding his ultimate fate. Apollodorus relates that Panthesilia, a woman warrior, slew many in battle and among them was Machaon. Quintus Smyrnaeus, who perhaps had before him the works of the Cyclic poets which have since been lost, records in a graphic way the manner of Machaon's death at the hand of Eurypylus, son of Telephus. His verses speak of a terrific struggle between the two men. Machaon received a spear thrust through his right hip but in spite of this grave injury he snatched a huge stone from the ground and dashed it on the head of his enemy whose helm saved him from disaster. This blow infuriated Eurypylus who drove his spear straight through Machaon's breast. The dying man had scarce breath to foretell his opponent's fate—that he would himself fall on the plain of Troy and that very soon. " What care I for the future " Eurypylus vauntingly cried. " You are dead, this day is mine, and every man's fate is preordained." This charming custom of gloating over the fallen would not pay a dividend in modern high-speed warfare. Anyone who paused to tell the world just how it was done would soon receive a severe buffet in the rear to remind him of the business in hand.

The recovery of Machaon's body led to desperate fighting and caused a host of men to perish on either side. News of his brother's death is

brought to Podalirius who is hard at work dressing the injuries of those struck down in battle. The merciful surgeon is transformed into a relentless avenger; he donned armour and hurled himself into the struggle where till darkness fell he fought madly to requite his loss. With the end of hostilities grief overwhelms him and he has to be restrained from falling on his sword. He is seeking amongst his herbs for a deadly drug when Nestor appears to comfort him. " Do not grieve over the fallen, his end was worthy his life. I lost a son, and to all men Fate assigns one same sad lot—Bereavement. All happy is no living man. Hope on, for sure am I that to the company of gods shall he ascend." Thus saying, Nestor drew the stricken man from the grave and back to the ships they slowly made their way.

Sprengel has a different and less tragic story to tell. His version is that Machaon survived the war and in Messinia founded the towns of Tricca and Oechalia. His wife, Anticlea, daughter of Diocles, King of Messinia, bore him five sons who followed their father's profession which was carefully preserved in the family.

PODALIRIUS

References to the life and work of Podalirius are disappointingly few but there is something of romance by way of compensation. It is said that he was endowed with great precision of mind, with the power to recognise hidden diseases, and to cure chronic maladies. He it was who first perceived by his glittering eyes and depression of spirits the insanity of Ajax. In the *Iliad* his name occurs twice only, while that of his brother is mentioned 11 times. He used a " kwick-cure " salve which healed wounds in a miraculous fashion. He first pressed out clotted blood, then deftly knit up the gashes and applied ointment which had power to heal in one day. Even in very serious injuries and apparently cureless wounds pain was at once assuaged and healing rapidly followed.

In the *Aeneid* it is said that Podalirius was one of the warriors concealed in the Wooden Horse. When the Greeks sailed away in their ships, pretending to abandon the siege, they left behind a huge wooden building filled with armed men who when darkness fell were to be released by Sinon the spy. Such a trick would not deceive a Brownie but the Trojans, " blinded by their fate," obligingly dragged the Horse into the city and so accomplished their own destruction.

A WEDDING

On the homeward voyage from Troy the ship bearing Podalirius was cast by a tempest upon the isle of Scyros where he was washed ashore safe and sound. There he was found by a shepherd who conducted him to King Damethus whose daughter had fallen from a house-top and lay unconscious and was regarded as dead. Podalirius bled her from both arms and had the happiness of recalling her to life. Damethus, full of

gratitude, gave him his daughter in marriage together with the peninsula of Caria as a wedding gift. Thus he was probably the first medical practitioner in history to be won by a fair and interesting patient.

Lycophron asserts that Podalirius was assassinated by the Dauni who afterwards worshipped his memory. Also that he was buried at Apulia in Italy and for so saying was severely taken to task by his learned but crabbed commentator, Tzetzes, who roundly accused him of lying.

Strabo says that the tomb of Podalirius may be seen a hundred stadia from the sea in the country of the Dauni and he adds that the waters of the river Althenus, by virtue of the presence of the tomb, were a sovereign remedy for the diseases of cattle.

Apollodorus states that the two brothers were among the suitors for the hand of the wonderful Helen of Troy which appears to have been the fate of any man who had the misfortune to gaze upon her supernatural charms. The courage of her suitors must have been of a high order to enable them to woo a being of whom Marlowe in his " Dr. Faustus " exclaims,

> " Oh ! thou art fairer than the evening air
> Clad in the beauty of a thousand stars ! "

FOOTNOTES

(1) The strange connection of Medicine and Snake has persisted down the ages and may be partly justified by the fact that the word Asklepios is derived from a root which means to " wriggle." The symbolism of the Royal Army Medical Corps badge is very ancient and goes back to nebulous times, far anterior to Æsculapius, even to the dreamland of mythology—to the snake-god himself.

(2) The fleet assembled in the Bay of Lemnos and the troops landed on the southern shore of the Hellespont to besiege Troy which lay near the mouth of the Dardanelles ; Lemnos, an island in the Aegean Sea, serving as base.

(3) Machaon appears to have " lost his head " when dealing with Menelaus's wound. Instead of removing the belt—a heavy brass-bound affair—to ascertain the extent of the injury, he lugged out the arrow by main force and thereby damaged the barbs. The incident is recorded in Book 4 of the *Iliad* but translators differ regarding what really happened. We are variously informed that the barbs of the arrow were bent ; that they were broken off ; while the fanciful Pope writes :
> " Where to the steely point the reed was join'd
> The shaft he drew but left the head behind."

No mention is made of the arrow shaft which, in the Arms of this College, is shown fractured near the end. If made of ash—we read of the warriors' *ashen* spears—it might bend but not break on impact, and the force applied to free the arrow would be in its line and not at a right angle. Apparently the artist who drew the broken shaft held by Machaon literally missed the " point " of the story. On the other hand he may have been influenced by the lines in Garth's " Dispensary " where, figuratively, the shaft *is* broken :
> " Machaon, whose experience we adore,
> Great as your matchless merit, is your power.
> At your approach the baffled tyrant, Death,
> Breaks his keen shaft and grinds his clashing teeth."

(4) The curious mixture of wine, grated cheese and barley meal has been subjected to a great deal of criticism, much of it adverse. Plato said it was inflammatory ; Eustathius that it was given as refreshment rather than remedy. Malgaigne distinguished between the recently wounded and those complicated by fever. Larrey, the great military surgeon, gave wine to his wounded even to those suffering amputation.

· According to Berdoe Homer's physicians were in the right ; good old wine was the best thing possible to restore a man fainting from loss of blood and cheese grated fine was a nutritious food. As though the matter were a debatable one even at the time of Troy the following unsympathetic judgment is attributed to the brothers: " If the men are sound " they said, " wine and cheese will not hurt them ; if they are not let them die and make room for better men."

A more detailed account of Podalirius and Machaon, of which the above is an abstract, was published in the *Lancet*, 1931, April 18th and 25th. A bibliography is there appended to which should be added a book by Professor O. Körner (*Die arztlichen Kenntnisse in Ilias and Odysse*. Munich, 1929) which was kindly brought to my notice by Dr. E. Fuld of Berlin, and Dr. F. B. Lund's *Greek Medicine* (Ohio Medica Series) Hoeber, New York, 1936.

SAYINGS OF THE GREAT ·

" The little that is done seems nothing when we look forward and see how much we have yet to do."—*Goethe* (Contributed by R. W. Raven, O.B.E., F.R.C.S.)

" If a great change is to be made in human affairs, the minds of men will be fitted to it ; the general opinions and feelings will draw that way. Every fear, every hope will forward it ; and then they who persist in opposing this mighty current in human affairs, will appear rather to resist the decrees of Providence itself, than the mere designs of men. They will not be resolute and firm, but perverse and obstinate."—*Burke.* (Contributed by R. W. Raven, O.B.E., F.R.C.S.)

" The patient is the centre of the medical universe around which all our works revolve and towards which all our efforts trend."—*J. B. Murphy.* (Contributed by Professor Lambert Rogers, V.R.D., F.R.C.S.)

" Far and away the best prize that life offers is the chance to work hard at work worth while."—*Theodore Roosevelt.* (Contributed by Professor Lambert Rogers, V.R.D., F.R.C.S.)

" Force, lucidity, unity, simplicity, economy of expression are virtues which we may all obtain ; originality will be as God pleases."—*Clifford Allbutt.* (Contributed by Professor Lambert Rogers, V.R.D., F.R.C.S.

Note.—Contributions are invited.

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" OBSERVABLES " AT THE ROYAL COLLEGE OF SURGEONS

12. A CRIMEAN CASUALTY

OCCUPATIONAL AND DIVERSIONAL therapy are not by any means recently introduced methods of helping convalescent patients towards recovery, as is shown by a picture by Thomas William Wood which was exhibited in the Royal Academy in 1855 and is now in the possession of the College. It was presented in January this year by the Artist's nephew, Alderman Thomas William Wood Roberts, D.L., J.P., of Croydon, and the gift was made on the suggestion of Major-General Sir Ernest Cowell, K.B.E., C.B., D.S.O., a distinguished Fellow of the College.

The picture shows Private Thomas Walker of the 95th Regiment of Foot who was wounded in the head at the Battle of Inkerman in 1854. He is engaged in making a patchwork quilt, and is wearing a cap which conceals the scar of a successful trephining operation.

Queen Victoria showed great interest in this soldier when she visited the Military Hospital at Fort Pitt, Chatham, on March 3, 1855, accompanied by Their Royal Highnesses Prince Albert, the Prince of Wales, the Duke of Connaught, and Prince Alfred. The hospital at Fort Pitt, which was originally built for an artillery barracks, was then the only general military hospital in England.

The following account of The Queen's visit is culled from contemporary sources. " The Queen showed her great sympathy with the sufferers on this her first visit to the only hospital in England in which the patients were received."

" Her Majesty drove from the station (Strood) to Fort Pitt, and was met as she alighted from her carriage by the Commandant, Mr. G. R. Dartnell, D.I.G.H., and the Staff Surgeons of Divisions. Her Majesty first visited the convalescents, and then passed into the Hospital where she spoke to each of the patients. Each had a card on which was printed his name, regiment, age, service, the nature of his wound, and in what action he was wounded, etc."

" One case especially interested The Queen and claimed her attention. This was Private Thomas Walker, 95th Regiment, who had been seriously wounded in the head by a shell which burst in the air immediately above him. Her Majesty asked many questions as to his comfort, his progress, his food, etc., all of which he described as satisfactory. It was stated that he had a silver plate fastened to the top of his skull."

The following information about the 95th Regiment of Foot has been obtained from the Librarian of the Royal United Services Institution.

" No fewer than six Regiments have borne successively the famous number ' 95 ' in the British Line, the last being the present 2nd Sherwood Foresters, late the 95th (Derbyshire) Regiment."

" The first five 95th Regiments were all disbanded before the year 1818 ; the fourth was The Prince Consort's Own—The Rifle Brigade."

" The sixth and last 95th (Derbyshire) Regiment was one of the new regiments added to the army in the reign of King George IV. It was raised on December 25, 1823."

" In 1881, the 95th became, under the Territorial reorganization, the 2nd Battalion The Sherwood Foresters. The 95th Regiment served in the Crimea from April, 1854, to July, 1856, and fought in the following battles : Alma, Inkerman, Tchnernaya, and Sebastopol."

Major S. L. A. Carter, M.B.E., M.C., Officer Commanding Regimental Headquarters, The Sherwood Foresters, has kindly traced Private Walker in the Records of the 95th Regiment, and finds that he was serving with the Regiment in the Crimea, and that his name is among the list of wounded. Major Carter also reports that the Bugle above the " 95 " on Walker's cap denotes that he was in No. 6 (Light) Company, known at that time as the " Light Bobs."

<div style="text-align: right">W-J.</div>

THE LIBRARY

THE HUNTER BAILLIE COLLECTION

WHEN WILLIAM HUNTER died in 1783, he left his medical museum and his collections of manuscripts, books and coins to Glasgow University, subject only to the life interest of his nephew, Matthew Baillie, who succeeded him in his school of anatomy. Baillie kept only certain personal things, among them the letter-book which Hunter had acquired from the family of Queen Anne's physician, John Arbuthnot. To this Hunter had added letters written to himself by famous or distinguished people. Ten years later Matthew Baillie was executor to his other uncle, John Hunter, but unfortunately John Hunter's papers passed into the hands of the co-executor, Everard Home.

Matthew Baillie lived till 1823 and came to be one of the leading London physicians of his day and a favoured friend at Court. He continued to add to the family collection letters which he received from his distinguished friends and patients. He also kept together the letters written to him by the Royal Princesses, all of which begin " Dear Baillie." Papers gathered by other members of the family were added : thus Mrs. John Hunter's manuscript poems, and the papers of Baillie's sister Joanna, also a poetess, came into the collection. Joanna Baillie who lived to be 88 (1762-1851) was an eminent blue-stocking, a successful writer of plays, and a close friend of Sir Walter Scott. Sixty-six letters to her from Scott are included in the collection. They were read and used by Lockhart for his life of Scott, and printed in full in the centenary edition of Scott's Letters. There is also a characteristic letter from Scott to Matthew Baillie about his illness from gallstones, which has been published by Sir Gordon Gordon-Taylor.

Matthew Baillie's wife was Sophia, daughter of Dr. Thomas Denman, whose reminiscences of his early life as a ship's surgeon have been quarried for some historical novels. Denman had a fashionable obstetric practice, in which he was followed by his other son-in-law, the ill-fated Sir Richard Croft, who killed himself after the death of his patient Princess Charlotte, the heir to the Throne. Denman's son became Lord Chief Justice and his grandson a High Court judge. Mr. Justice Denman interested himself in the family collection, helping Matthew Baillie's grand-daughters to complete the work, begun by Matthew's wife Sophia, of identifying and arranging the letters. He also brought into it a miscellaneous collection of autographs gathered by his side of the family. Matthew Baillie had been a friend of the great Edward Jenner and of Jenner's biographer John Baron, and at the end of his life settled near them in Gloucestershire. Through Baron a small collection of papers of Jennerian interest was added. Thus the collection represents the contacts through two centuries of a group of men and women of high distinction ramifying through the medical, legal and literary worlds. It forms a not unimportant fund of

Dear Jenner

I [send] yours in answer to mine, which I should have answered[.] I own I suspected it would not do; yet as I did intend such a scheme, I was inclinable to give you the offer. I thank you for your Expt on the Hedge Hog; but why do you ask me a question, by the "way" of solving it. I think your solution is just; but why think, why not trie the Expt. Repeat all the Expt upon a Hedge Hog as soon as you receive this, and they will give you the solution. Trie the [But] cut off a leg at the same place cut off the Head, and expose the Heart and let me know; the result of the whole

I am Dear Jenner
Ever [&] yours
John Hunter

[Aug] 2

JOHN HUNTER TO EDWARD JENNER. Why think, why not trie the Expt.
For a transcript of the letter see *Annals* page 224 (October.)

minor historical material, comprising more than a thousand letters from nearly five hundred writers. A detailed index has been made since the letters were given to the College. The older half of the collection was given by Matthew Baillie's son William, at the end of his long life in 1895, and the rest by William Hunter Baillie's daughter Helen, three years before her death in 1929. Miss Hunter Baillie included with her gift a copy of her own unpublished reminiscences.

The Hunter Baillie collection comprises also a number of manuscript books, the oldest of which is a *common-place book* of the early eighteenth century, giving details of family history of the Hunters. *Matthew Baillie's notebooks* include :—

Journal of a tour in Europe in 1788, extracts from which were published by V. G. Plarr, Librarian of the College, in 1927.

A short memoir of my life, 1818, printed by J. B. Bailey, Librarian of the College, in 1896.

Some brief observations drawn from my own experience upon a considerable number of diseases, in two volumes.

With these are his case-books, fee-books and other professional notes, including details of his attendance on King George III. Baillie records that his total annual fees mounted from £121 in 1792 to £9,995 in 1815.

The autograph letters are mounted in 10 large volumes :—

1. *John Arbuthnot's* letter book, published by G. A. Aitken in 1892. The most interesting letters are those of Pope and Swift and their circle written in 1714 when the Queen's death involved the destruction of their political hopes. With this is bound *William Hunter's* letter book. It includes letters from Tobias Smollett the novelist, from Dr. Johnson thanking Hunter for presenting his book to the King, and from Edward Gibbon " proposing himself the pleasure of attending some of Dr. Hunter's Anatomical lectures."

2. *Hunter and Baillie family* letters and reminiscences, including the letters written by John to William Hunter from active service in 1761-62. These have been printed in the biographies of the Hunters. *Jenner family* letters.

3. *Early XIX-century letters.* Letters to Baillie from the Royal Princesses. Letters of the *Bentham family*, including three from Jeremy Bentham.

4. *Denman family* collection ; with autographs collected by *Lady Bell*, and by *Dr. William Whewill* ; letters of *John Baron* ; letters from *Joanna Baillie's* friends.

5. *Scott's* letters to Joanna Baillie, which have all been published. *Maria Edgeworth's* letters to her.

6. *William Hunter's* diplomas, and letters to him ; Hunter family documents, and notes on family history compiled by Joanna and Matthew Baillie

7. *Matthew Baillie's* letters to William Hunter, and to his wife Sophia (Denman) and his diplomas.

8. *Matthew Baillie's* professional correspondence.

9. *Joanna Baillie's* letters and papers.

10. *Princess Mary's* letters to Baillie concerning the illness of Princess Amelia ; *Anne Hunter's* autograph poems.

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SCOTT, Sir W. (1937) Letter of 17 April 1819 to M. Baillie (facsimile). *Brit. j. surg.* **25**, 247.

MONTHLY DINNERS

Monthly dinners are held in the College on the second Wednesday of each month. The following are entitled to attend with their guests. All Diplomates and students of the College, and Members of the Associations linked to the College through the Joint Secretariat. It is not necessarily intended that guests should be members of the medical profession.

The dinners will be at 7 p.m. on the following Wednesdays : January 12, February 9, March 9, April 6, May 11, ·June 8 and July 13, 1949. There is an inclusive charge of £1 5s. (including drinks), which must be sent with the application to the Assistant Secretary at least a week before the date of the, dinner. The dress is Lounge Suit or Uniform.

DIARY FOR DECEMBER (15th-31st)

Wed. 15   3.45   PROF. C. MCLAREN WEST—The Female Breast and its Development.

           5.00   DR. D. J. BELL—Carbohydrate Metabolism.

Thur. 16   Pre-Medical Examination begins.

           3.45   PROF. T. NICOL—The Kidneys and Bladder.

           5.00   DR. D. J. BELL—Carbohydrate Metabolism.

Fri. 17   D. L. O. Examination (Part II) begins.

           3.45   MR. CLIVE BUTLER—The Surgical Anatomy of the Rectum and Anal Canal.

           5.00   PROF. A. C. FRAZER—Fat Absorption and Metabolism.

Thur. 23   College Closed.

Tues. 28   College reopens.

               Last day for applications for election to Court of Examiners.

Fri. 31   D.P.H. Examination (Preliminary) begins.

DIARY FOR JANUARY, 1949

Mon. 3   5.00   MR. C. E. SHATTOCK—Erasmus Wilson Demonstration.
—Tumours of Bone.*

Tues. 4   Final Membership Examination begins.
      5.00   MR. L. W. PROGER—Erasmus Wilson Demonstration.—New additions to the Museum.*

Thur. 6   D.P.H. Examination (Final) begins.
      5.00   PROFESSOR ARNOLD SORSBY—The Treatment of Ocular Infections.*

Mon. 10   5.00   DR. MAGNUS HAINES—Erasmus Wilson Demonstration.*

Tues. 11   5.00   MR. C. E. SHATTOCK—Erasmus Wilson Demonstration.—Diseases of the Breast.*

Wed. 12   7.00   Monthly Dinner for Fellows, Members and Licentiates (see page 347).

Thur. 13   5.00   PROF. R. H. GOETZ—Arris and Gale Lecture.—The diagnosis and treatment of Vascular Disease.*

Fri. 14   5.00   PROF. R. H. GOETZ—Arris and Gale Lecture.—The diagnosis and treatment of Vascular Disease.*

Wed. 19   5.00   MR. L. W. PROGER—Erasmus Wilson Demonstration.—New additions to the Museum.

Fri. 21   Final L.D.S. Examination (Part I) begins.

Mon. 24   5.00   DR. A. SCHWEITZER—Cardiac Mechanics.
      6.15   PROF. J. WHILLIS—Functional Activities involving the Mouth and Pharynx.

Wed. 26   Primary F.R.C.S. Examination begins.
      5.00   PROF. D. T. HARRIS—Respiration (Part 1).
      6.15   DR. D. LONG—The Application of Penicillin to Dentistry.

Thur. 27   5.00   MR. R. J. LAST—Anatomy of the Larynx.
      6.15   PROF. D. T. HARRIS—Respiration (Part 2).

Fri. 28   Final L.D.S. Examination (Part II) begins.

Mon. 31   5.00   PROF. G. P. WRIGHT—Spread of Infection in Tissues.
      6.15   DR. C. H. TONGE—Anatomy of the Oral Cavity.

* Not part of courses.

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